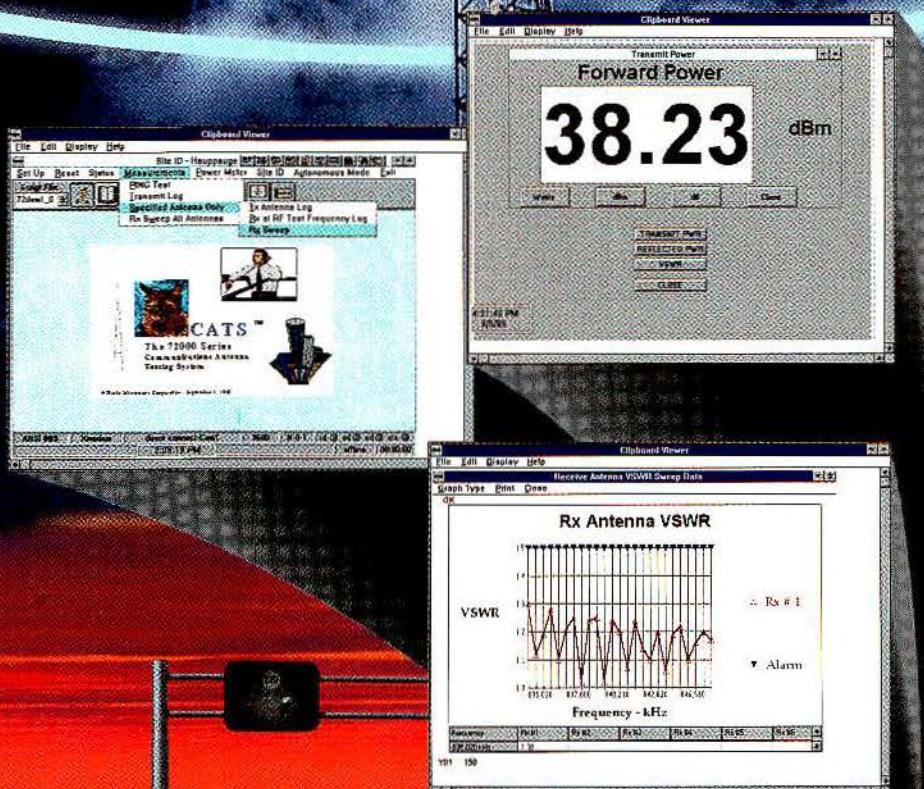


April 1996

# Mobile Radio Technology™

Technical information for paging, SMR and private wireless networks.

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VSWR  
measurements ..... p. 10

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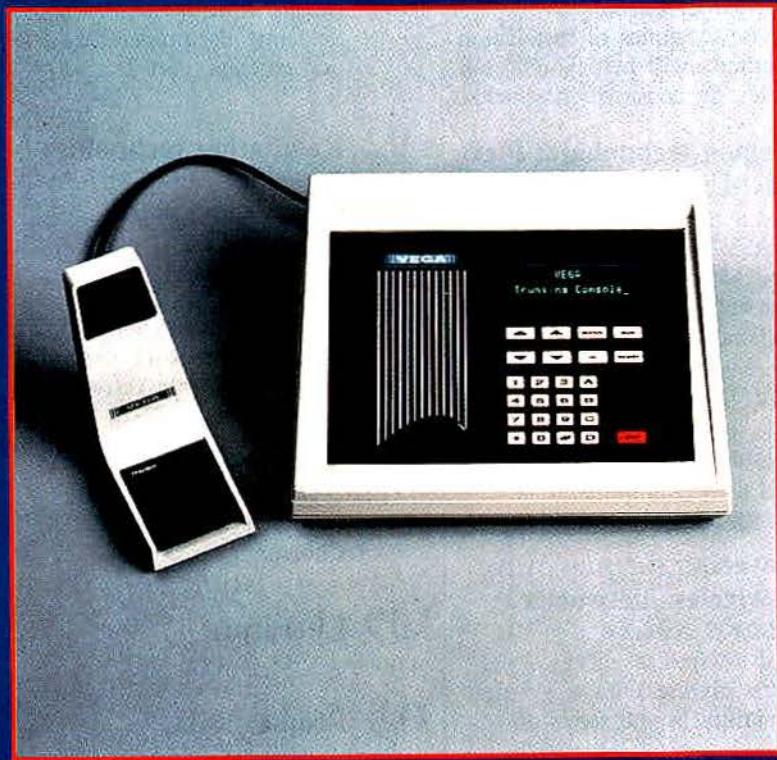
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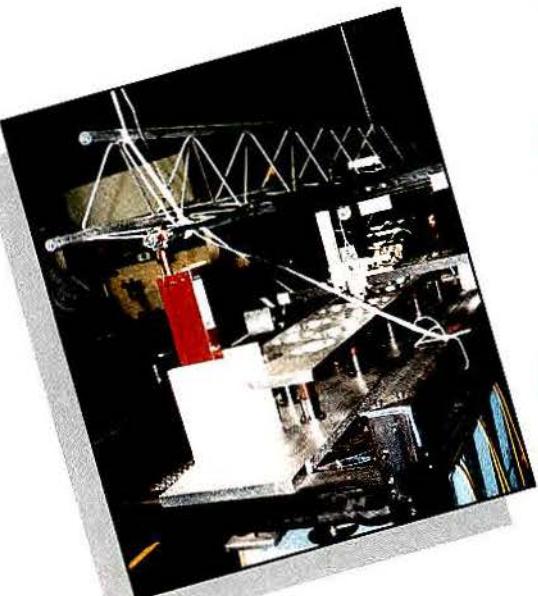
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On the cover: An antenna monitor measures forward and reflected power levels on transmit antennas, evaluates receive antennas and calculates VSWR for both. See Robert Koelzer's article on page 10.



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# Introducing the Phoenix SC20-500

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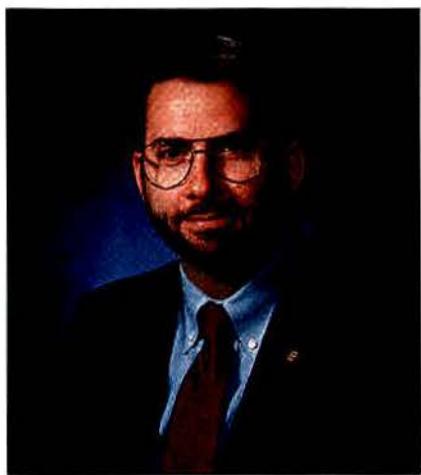
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See the Phoenix SC20-500 at  
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## New trade association: Small Business in Telecommunications



You can't win if you don't try.

Owners of small telecommunications businesses have been underestimating their market strength, says Robert H. Schwaninger Jr., a partner with Dennis C. Brown in the Washington, DC-based law firm of Brown and Schwaninger and our regulatory consultant and columnist.

At a March 1-2 meeting in St. Louis attended by 75 telecommunications business owners, Schwaninger invited them to join a new trade association, Small Business in Telecommunications (SBT), dedicated to representing small business before the FCC, Congress and federal courts. "Small business is being told the big lie," he said. "Don't try. You can't win." In reality, he explained, "You can't win if you don't try."

SBT formed quickly, moving on March 2 to assemble an 11-member board of directors and to hold an election for a chairman by mid-March. Small businesses are threatened by certain FCC decisions that Schwaninger said ignore the agency's own rules and regulations and federal law. "The fact is that small business can combine to achieve victories before the FCC, in the courts and in the halls of Congress," he said.

Small business has been put in a position of sounding too much like a whiner and challenger to change, rather than as the messenger of common sense, equity, fairness and the protector of the free market, Schwaninger asserted. "When an industry segment stops forwarding its agenda, it becomes vulnerable to having its agenda and opportunities shaped by others," he said.

To shape a political and regulatory environment in which small telecommuni-

cations businesses thrive, Schwaninger told the audience, small business must accomplish the following:

- Organize effectively.
- Become adequately informed.
- Focus on realistic goals.
- Become politically active.
- Become empowered.
- Maintain commitment and vigilance.

### 800MHz is a beginning

Schwaninger sees the regulatory proceedings involving specialized mobile radio (SMR) and enhanced SMR (ESMR) telecommunications systems as only one battleground in the conflict between small and large businesses. Although there are exceptions in the form of regional systems, most SMR systems provide *radio communications* service to local areas. Most ESMR systems are intended by current and prospective builders to provide regional and national *wireless* services, such as cellular telephone, paging, messaging and personal communications services (PCS).

Two tasks lay before small businesses with respect to 800MHz systems.

► The first task is to show that pending regulation will not work to the benefit of the American public. One example is the auctioning of spectrum for economic area (EA) licenses that conflict with existing SMR systems throughout the country. (See "The FCC's 800MHz Auction: Why It Won't Work" on page 82.) If held, these auctions can be expected to prevent any further expansion of small telecommunications businesses with 800MHz SMR systems.

Challenges to the FCC auction plan include the following:

- that the commission's rules do not meet its Congressional mandate requiring a demonstration of opportunity for small business, women and minorities.
- that the commission's system construction and channel use requirements would provide opportunities for extended warehousing of spectrum.
- that the commission has not demonstrated that more than a small, discreet group of operators are positioned to ever gain licenses and to construct and operate the EA-based systems, including the provision of service from systems using contiguous spectrum.
- that the commission has not demonstrated its legal authority to engage in auctions for the stated purposes.

► The second task is to recover channels assigned for ESMR use for reassign-

ment by the application process. For example, licenses for thousands of channels held by the largest ESMR operator were granted under a waiver issued March 14, 1991. The waiver spells out a five-year construction period, after which the licenses are to expire. Brown and Schwaninger has filed a Petition for Special Relief asking the FCC to prevent the ESMR operator from continuing to hold authorizations for unconstructed stations beyond March 14, 1996.

If auctions of the type proposed by the FCC (covering economic areas) would be held, recovery of these channels would allow small businesses a better opportunity to bid for EA licenses. The current warehousing of unconstructed channels by ESMR operators would make it difficult in some cases and impossible in most others for small businesses to bid.

Additional efforts to recover channels may be undertaken. For example, a petition might be filed asking the FCC to set aside certain ESMR channel grants because the original applications, many of which seem to have been hastily prepared, did not meet FCC requirements.

Another challenge may be based on evidence offered that in-house counsel to one of the ESMR companies may have committed perjury and may have attempted to induce others to commit perjury in statements submitted to the FCC in a finder's preference case. The commission thus far has ignored the matter, but a hearing could result in the loss of all of the ESMR's licenses, freeing thousands of channels.

### Future regulations

If the FCC's current plans for 800MHz SMRs are successfully implemented, there might be little to prevent the agency from using a similar blueprint for the other land mobile frequency bands and for other services, such as paging. Participation in SBT represents a good opportunity for two-way radio dealers, communications service resellers, and operators of small paging and SMR systems to protect their current interests and to secure a future in the telecommunications industry.

For the present, SBT shares offices with Brown and Schwaninger, and can be reached at 1835 K St. NW, Suite 650, Washington, DC 20006; tel. 202-223-8728; fax 202-659-0071. The association will be represented at the International Wireless Communications Expo in Las Vegas, NV, April 24-26.

—Don Bishop

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- 24-26—International Wireless Communications Expo**, co-sponsored by *Mobile Radio Technology*, Las Vegas Convention Center, Las Vegas. Contact: 800-828-0420.
- 28-May 1—Vehicular Technology Conference**, sponsored by IEEE Vehicular Technology Society, Westin Peachtree Hotel, Atlanta. Contact: Wendy Rochelle, 908-562-3870; Fax 908-981-1769.

## May

- 14-17—PCIA Spring Government Conference**, sponsored by the Personal Communications Industry Association, Washington Hilton, Washington, DC. Contact: Nancy Palleschi, 202-467-4770.
- 29-31—Canadian Wireless**, sponsored by the Canadian Wireless Telecommunications Association, Metro Toronto Convention Center, Toronto. Contact: 613-233-4888.

## June

- 16-20—UTC National Conference & Exhibition**, sponsored by UTC, The Telecommunications Association, Marriott Hotel and Bartle Hall Convention and Civic Center, Kansas City, MO. Contact: 202-872-0030.
- 24-27—Supercomm**, sponsored by USTA and TIA, Dallas Convention Center, Dallas. Contact: 202-326-7300.

## July

- 11-13—Communications Expo>Show of the Americas**, Miami, FL. Contact: 305-229-9992.
- 14-17—Forestry-Conservation Communications Association annual conference**, Howard Johnson Plaza Hotel, Madison, WI. Contact: Tom Tuttle, 608-246-7998.

## August

- 11-15—International Association of Public-Safety Communications Officials (APCO) National Conference**, San Antonio, TX. Contact: 800-949-2726.

## September

- 19-21—Personal Communications Showcase**, sponsored by the Personal Communications Industry Association, Moscone Convention Center, San Francisco. Contact: 800-326-8638.

## October

- 30-Nov. 1—WirelessWorld Conference and Exposition**, sponsored by *Cellular Business* and *Mobile Radio Technology* magazines, Orange County Convention/Civic Center, Orlando, FL. Contact: Susan Link, 913-967-1969.

## November

- 22—Radio Club of America, Communications Symposium**, 87th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

- 18-19—AMTEX**, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Intercontinental Hotel, Miami. Contact: 202-331-7773.

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## April

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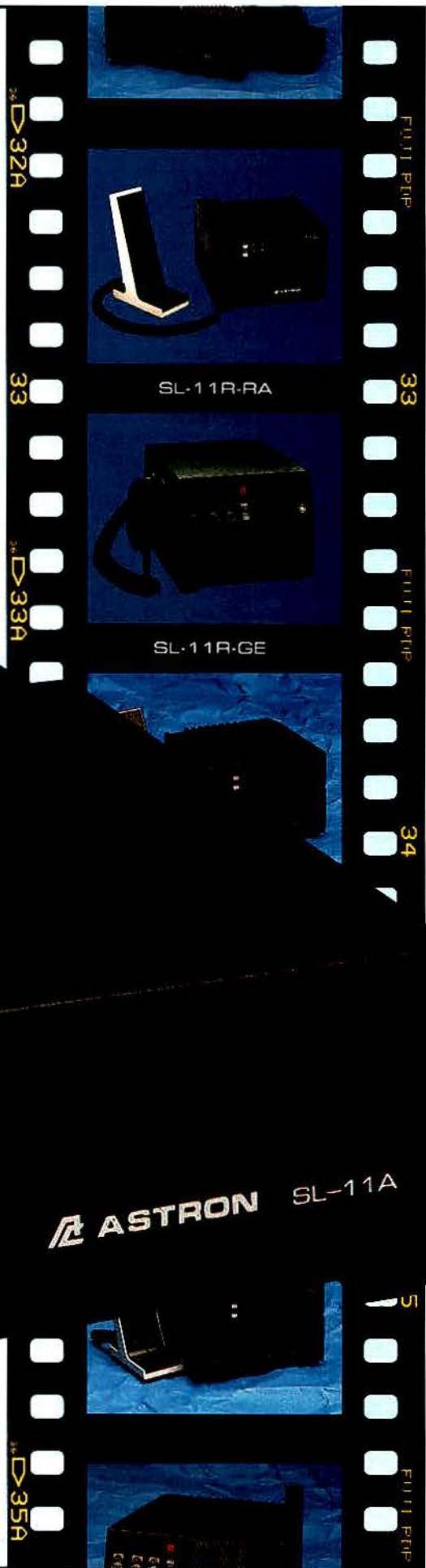
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## Selecting the proper base station antenna—Part 2

By Harold Kinley, C.E.T.

Last month, the most important electrical specifications of base station antennas were discussed. This month we will look at some of the mechanical specifications and then get down to choosing the best antenna to suit the requirements of various situations.

### Mechanical considerations

There are some important mechanical considerations that should be taken into account when selecting a base station antenna. *Lateral thrust, bending moment and torque* are some of the more important factors.

► **Lateral thrust** — Lateral thrust is side force exerted upon an antenna by the wind. (See Figure 1 below). Lateral thrust is dependent on the *equivalent flat plate area* of the antenna and upon the wind velocity. The greater the equivalent flat

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is a member of the Radio Club of America. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301.

plate area or the greater the wind velocity, the greater the lateral thrust exerted on the antenna. Generally, a wind velocity of 100mph is taken as the reference. At 100mph, the lateral thrust exerted on an antenna is taken as 40 pounds per square foot (40psf or 40lbs/ft<sup>2</sup>). The formula for determining the lateral thrust is

$$F = kAV^2$$

where

$F$  = force of lateral thrust in pounds per square foot

$k$  = wind correction factor (generally taken to be 0.004)

$A$  = equivalent flat plate area

$V$  = wind velocity in miles per hour.

By substituting the reference wind velocity of 100mph acting upon an area of 1ft<sup>2</sup> into the formula, we find the lateral thrust to be

$$0.004 \times 1 \times 100^2 = 40\text{lbs}/\text{ft}^2$$

Thus, if an antenna has an equivalent flat plate area of 2ft<sup>2</sup>, then the lateral thrust is  $2 \times 40 = 80\text{lbs}$  of lateral thrust.

► **Bending moment** — Lateral thrust produces a force, called *bending moment*, on the antenna support. This specification is usually given for the point at the top mounting clamp as shown in Figure 2 below.

► **Torque** — In Figure 3 at the right, a side-mounted antenna "catches" the wind, and as a result of the lateral thrust exerted on the antenna, a twisting force, or *torque*, is exerted on the tower. To reduce the

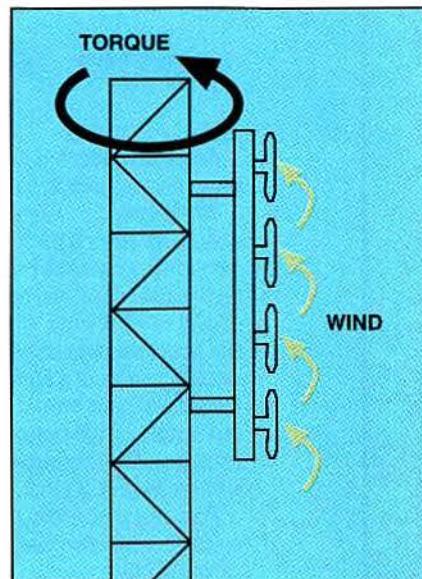


Figure 3. Wind acting on a side-mounted antenna applies a twisting force, referred to as *torque*, on the tower. Torque can be reduced by installing special torque resistors on the tower to serve as tie points for the guys.

torque exerted on a tower, special *torque resistors* are used. Basically, a torque resistor is just a horizontal extension mounted to the tower to provide guy points further from the center of the tower. This allows the guys to overcome the torque produced by the wind similar to the way that a simple lever provides more leverage the further it is from the fulcrum.

► **Ice loading** — The effects of ice loading on a tower are caused by more than just the weight of the ice. Buildup around the antenna increases the surface area of the antenna, thus increasing its wind resistance. To illustrate, a round antenna rod 2ft long with a 1" diameter has an equivalent flat plate area of  $24 \times \frac{1}{3} = 16\text{in}^2$ . If the same antenna rod were covered by  $\frac{1}{2}$ " of ice, the diameter would become 2", thus doubling the equivalent flat area of the antenna rod and thereby doubling the lateral thrust on the antenna. The  $\frac{1}{3}$  correction factor is used in the above calculation because round surfaces are considered to have wind resistance equivalent to  $\frac{1}{3}$  that of a flat surface.

### Other considerations

Service area and possible interference also must be considered in choosing the proper base station antenna.

► **Service area** — Before choosing the

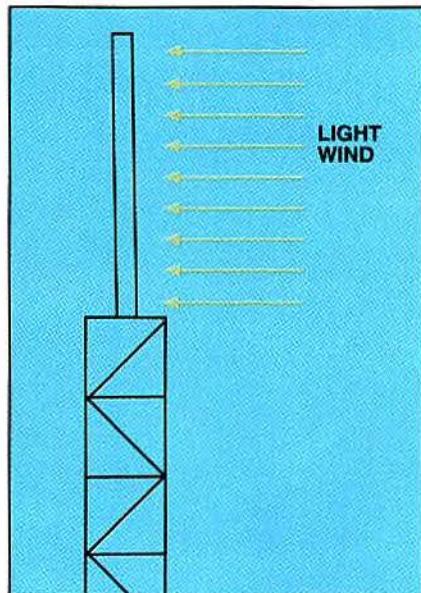


Figure 1. Wind acting on the antenna will produce lateral thrust. The degree of lateral thrust depends on the equivalent flat area of the antenna and the wind velocity.

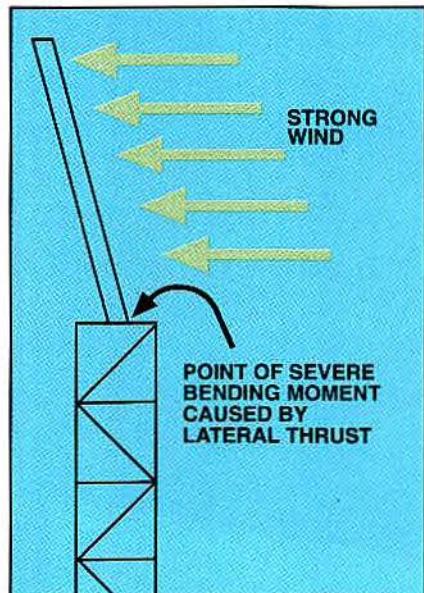


Figure 2. A high degree of lateral thrust caused by strong wind causes a severe bending moment at the top antenna mounting clamp. This stress is also transferred to the tower.

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# Exploit the power of VSWR measurements

*VSWR measurement, one of the most basic measures of RF system performance, lets system operators stay on top of base station antenna performance without leaving the office and can predict impending failures.*

By Robert Koelzer

The current explosion of personal communications services (PCS) brings with it a raft of new measurements geared toward evaluating various elements of system performance. The testing of communications protocols gets the most recognition, al-

though the accurate measurement of forward and reflected power and voltage standing wave ratio (VSWR) continue to be basic determinants of RF system performance.

VSWR is perhaps the simplest qualifier of system health, and it can yield important information about whether or not that health is deteriorating. Surprisingly, system operators sometimes assume that because there

have been no complaints about a particular cell in a cellular system or a particular sector of an SMR system, no periodic VSWR measurements need to be made. However, ignoring this simple performance diagnostic can have costly consequences.

Fortunately, it has become quite simple to perform VSWR measurements on a regular basis and to send the resulting data to a remote location on either a dial-up line or via a wireless telemetry system.

## The test environment

Nearly every land mobile, cellular or PCS system uses multiple transmit and receive antennas. Each one is responsible for blanketing a sector of the desired coverage area. Many systems have six transmit and six receive antennas, and some even more.

Monitoring the VSWR of the transmission chain from the transmitter and receiver through the transmission line and connectors to these antennas can be extremely helpful. VSWR is the ratio of power that is sent forward to the antenna to the amount of that power that is reflected back toward the transmitter because of standing waves on the transmission line and the terminating load, the antenna.

As VSWR increases, transmitted power decreases to the point at which no power is radiated. Beyond the obvious degradation of system performance caused by a high VSWR, the condition places an increased burden on transmitter components because the mismatch presented is well beyond the optimum.

This scenario applies equally, yet less obviously, to the receive side of the system, where performance degrades rapidly as

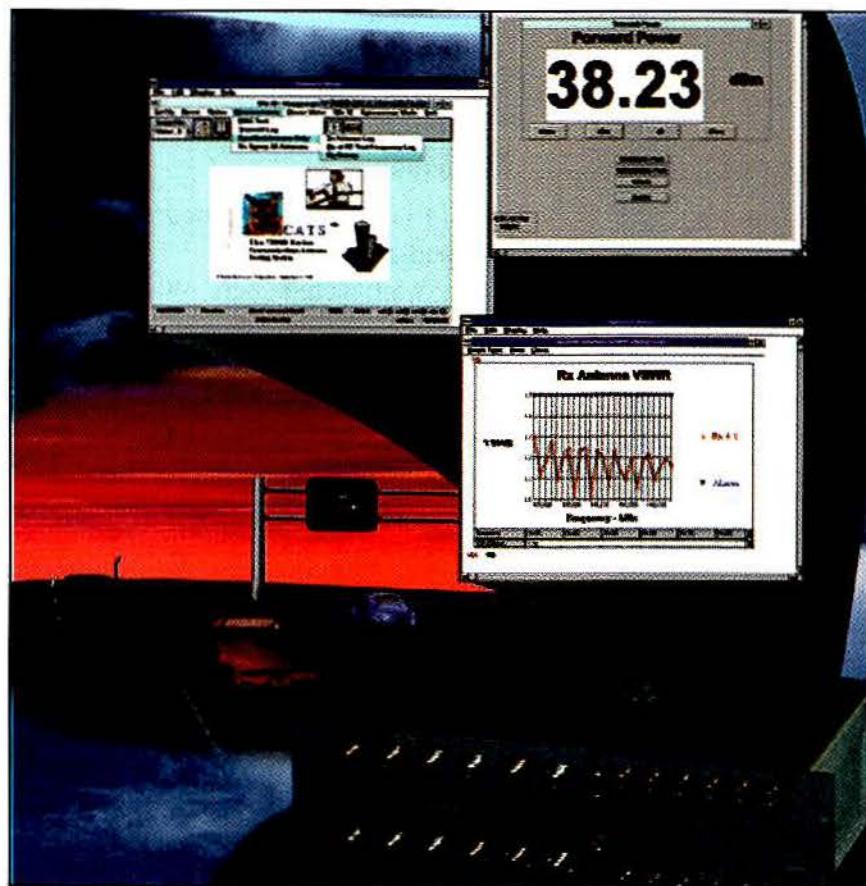


Photo 1. The model 72000 antenna monitor measures forward and reflected power levels on transmit antennas, evaluates receive antennas and calculates VSWR for both. By selecting the VSWR menu item (see insets), the user can move quickly from sensor to sensor when making measurements. A true RMS power meter registers multi-signal complex modulation for cellular and SMR signals.

Koelzer is product line manager, wireless/cellular products, at Loral Microwave-Narda, Hauppauge, NY. The company manufactures the Continuous Antenna Monitoring System (CATS) 72000 Series VSWR/Power Monitor described in the article.

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#### **SL Series Mobiles:** (above)

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- ▲ Built-in CTCSS, DCS & Two Tone Sequential

#### **PT Series Portables:** (above)

- ▲ 5 watts power VHF (150-174 MHz)
- ▲ 4 watts power UHF (450-512 MHz)
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#### **WHS Series Portable:** (left)

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VSWR increases. Most often, the primary concern in the receive link is receiver sensitivity and a low LNA (low-noise amplifier) noise figure. Of course, a poor antenna feed circuit with a high VSWR completely negates the best LNA noise figure.

The consequences of a high VSWR condition are most obvious to the users of the system. In cellular service, calls are dropped, reception is poor and overall performance is unacceptable in the cell (or section of cell)

covered by the base station antenna with the high VSWR. Performance degradation is most noticeable as a lack of coverage in some areas, as poor reception and, in the worst cases, as nearly complete disruption of communication or as a dropped cell.

Perhaps more onerous is the possibility of gradual degradation from an extremely low (favorable) VSWR at the time of installation to an extremely high VSWR over a long time. There are many potential

causes for this condition, including damage at the time of installation, weathering, corrosion, vandalism and storm damage.

As competition for consumer and business communications dollars increases, a poor-performing RF transmission system causes a crescendo of complaints and finally a search for alternative communications providers. All for the lack of measuring a basic RF performance parameter.

#### If it ain't broke...

In an ideal world, every system operator would have the time and resources to take RF system performance into account and to conduct periodic checks of VSWR to ensure optimum system behavior.

However, this has been difficult to do, because sweeps of antenna performance over the full system bandwidth require skilled technicians and expensive analytic equipment. In addition, traffic must be disrupted while measurements are made, and the collected data must be compiled manually and presented to RF engineers for review. As a result, these measurements have been made infrequently, and sometimes not at all.

Because many base stations are in remote, even severe environments, it is a rare occasion when someone volunteers to journey to a base station simply to make a measurement on a system that "appears to be working OK."

On arriving, technician is faced with making measurements on each transmission line, one by one, and recording the data manually. This can take a long time on a large, multi-sector system. It can also require taking the system down to install a calibrated, dual-directional coupler with high directivity as the power sampling port.

In addition, making VSWR measurements on the receive section requires injecting a signal onto the line, which, if done manually, shuts down that sector until the measurement is made, which in turn halts communication in that sector while the test set-up is being installed and the receive antenna feed measurement is being made.

Finally, a single measurement such as this is of questionable value, because transmission line conditions can change the moment the technician goes "back down the mountain." Multiple measurements over time are required to produce enough data to generate a history of VSWR performance. It is this trend information that is the most powerful exploitation of VSWR as a system evaluation tool.

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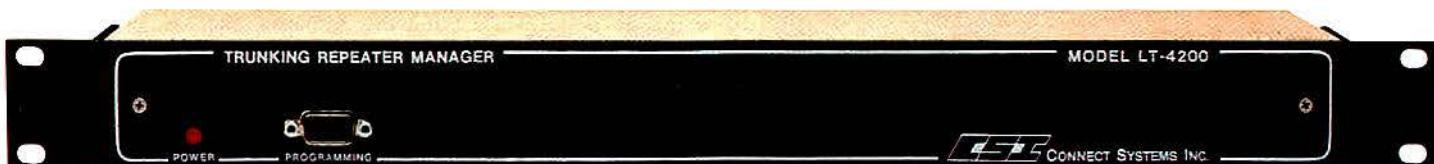
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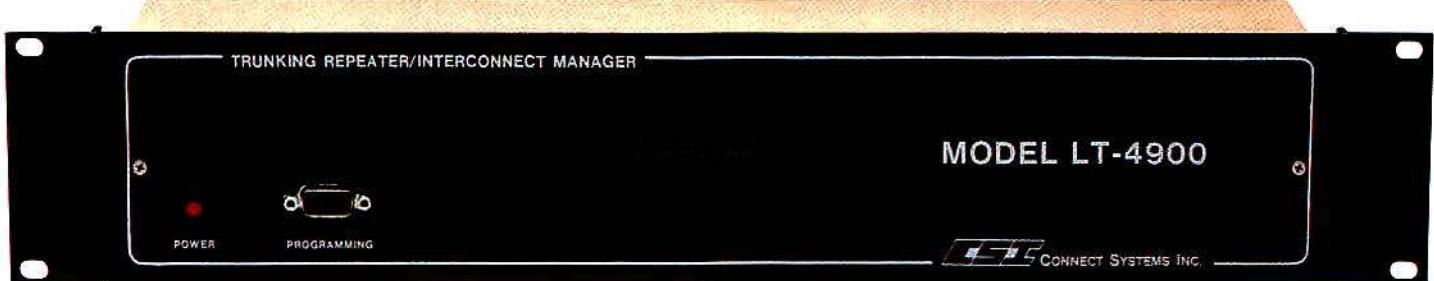
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**Table 1—The 72000 series cell site VSWR/power monitor.**

Number of sensors .....	As many as 12 (1 to 6, receive; 1 to 6, transmit)
<b>TRANSMIT SENSORS</b>	
Frequency range .....	800MHz to 900MHz*
Input power levels	
Forward power .....	6mW to 600W
Reflected power .....	150mW to 150W
Measurement accuracy	
Forward or reflected power .....	±0.3dB at 25°C, ±0.5dB at 50°C
<b>RECEIVE SENSORS</b>	
Frequency range .....	824MHz to 849MHz
Insertion loss .....	0.2dB maximum
Main line VSWR .....	Less than 1.1:1
Test signal power level .....	10mW maximum
VSWR measurement range .....	1.07:1 to 10:1
VSWR accuracy	
To 1.2:1 .....	+0.10dB, -0.08dB
To 1.5:1 .....	+0.15dB, -0.10dB
To 2:1 .....	+0.30dB, -0.20dB
To 3:1 .....	+0.50dB, -0.50dB
Computer interface .....	RS-232D (9-pin D connector)
Data rate .....	Variable from 500bps to 9,600bps
Temperature range .....	0°C to +50°C
RF connectors .....	Type N female

\*GSM model (72566G) covers 935MHz to 965MHz

make VSWR measurements pay off is to perform them with a system in place at

gathered by the system can be communicated from the cell site or base station to

each base station or cell site. Results can be transmitted to a remote point (via a modem and telephone line or a microwave link), or to a local point (either a notebook computer for immediate analysis, or to a workstation for later retrieval and analysis).

One product, a continuous antenna monitoring system VSWR/power monitor, provides this type of functionality while providing complete characterization of the transmission path on both transmit and receive antennas without operator intervention.

The in-line system simultaneously monitors the forward and reflected power of the transmit antennas and determines the VSWR of the antenna feed circuit. The information

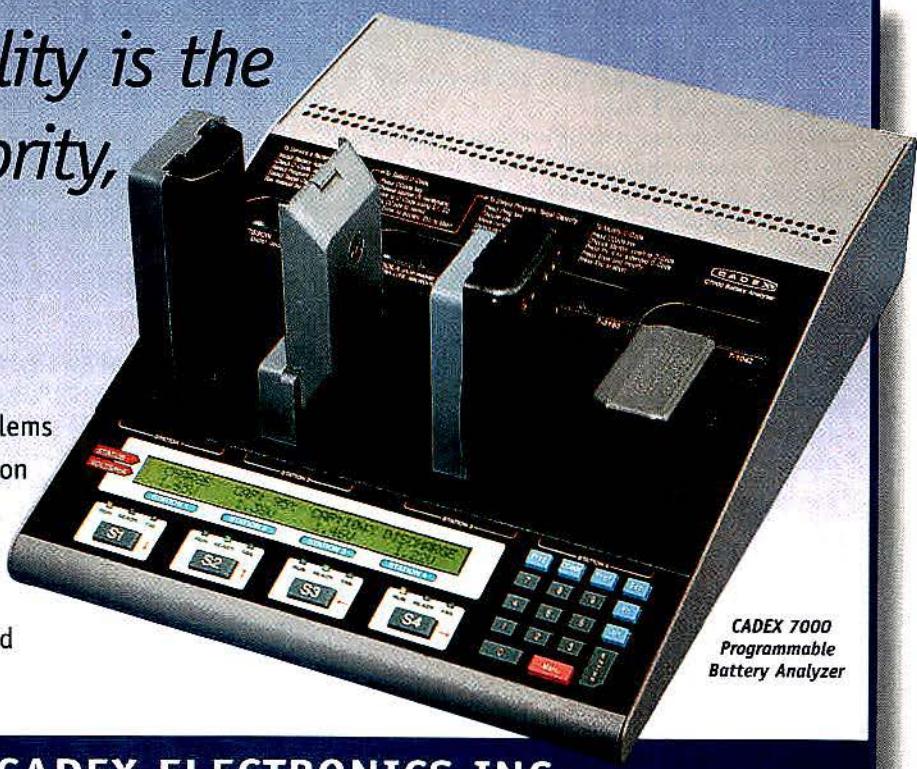
the operations center for analysis, and preset alarms can be set to alert system operators that an out-of-limit condition has occurred. In addition, receive antenna status is determined without degradation of system performance.

One model of the system also has onboard storage of up to six months of daily receive antenna sweeps and transmit power measurements. It includes Windows-based CELLPRO Plus software that allows a trend analysis to be conducted, and it has many other functions such as alarm functions, accurate transmitter power measurement and passive receive antenna frequency plots.

The monitoring system operates at standard cellular and land mobile frequencies. On the transmitter side, the system can monitor power levels as high as 600W average and 7kW peak, with ±0.5dB measurement accuracy from 0°C to +50°C. (See Table 1 at the left). Even more significant, at room temperature, the worst-case accuracy is ±0.3dB. Each model provides more than 30dB of dynamic range for transmit power measurement in three ranges of maximum power (50W, 200W and 600W). Models are available to meet AMPS, NAMPS,

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TDMA, and GSM requirements.\*

The system includes an RS-232 interface for direct connection to a computer or another remote monitoring device. The transmission monitoring section employs individual antenna sensors, which are high-directivity, in-line couplers that work with an embedded microprocessor to monitor the forward and reflected power levels. The system uses the microprocessors for control, calibration and communications, and GaAs (gallium-arsenide) circuitry is used for making precise multisignal power measurements with high dynamic range. The transmit monitors also have an extremely accurate true RMS (root-mean-square) power meter, which determines transmit power at any time, to confirm that all power amplifiers are performing acceptably.

The system's receive antenna sensor portion consists of a multiplexed ultralow-power synthesized transmitter and a receiver. The transmitter is actually a phase-locked-loop, precision frequency synthesizer stabilized by a crystal reference oscillator. It injects test signals into a cell site's receive circuitry to check forward and reflected power levels. Only 220dBm of test signal power is used in the monitoring system's receive antenna monitor, so that the signal reflected back from a defective antenna will not disturb the system or radiate spurious signals.

A low-loss, high-directivity coupler with less than 0.10dB typical insertion loss is used in the receiver monitoring architecture, which provides a virtually transparent receive signal monitoring port. The coupler's insertion loss is kept low through the use of design techniques proven in our manufacture of similar products for aerospace applications for more than 45 years.

Individual sensors within the system are connected via an RS-485 bus that supports remote control and data transfer. The RS-485 bus is converted to an RS-232 output bus within the monitoring system. The sensors are addressed by means of individual identification numbers.

The continuous antenna monitoring system VSWR/power monitor can be used for single- or multiple-frequency measurements. (See Photo 1 on page 10.) In the single-frequency mode of operation, the controller requests a measurement from the addressed sensor. The sensor sets its synthesized source to the commanded frequency, performs a calibration, transmits

\*AMPS is Advanced Mobile Phone Service.  
NAMPS is Narrowband Advanced Mobile Phone Service.

TDMA is time-division multiple-access.

GMS is global system for mobile communications, formerly Groupe Speciale Mobile.

the test signal, measures the reflected power level and terminates the transmission. The monitor calculates the VSWR and reports it back to the controller. A new frequency, antenna or both are then selected by the controller.

In full-band operation, frequency switching is automated to provide VSWR measurements at 25 frequencies across the receive band. Band A, band B or both can be selected by the user, as well as any 30kHz band from 800MHz to 960MHz. The calculated VSWR values are stored. Upon request, the monitor sends the antenna identification number, measurement frequencies, and measured VSWR values to the controller. This process can be repeated for any other receive antennas in the system and can be used to provide a running log of VSWR as a function of frequency and time for all of a site's receive antennas.

The system uses CELLPRO Plus Windows-based software to facilitate setup and measurement. (See Photo 1.) Combined with the popular ProComm Plus communications software, CELLPRO Plus forms a comprehensive remote site RF monitoring package. RF-specific menu choices include power/VSWR meter, status, set up, alarm, alarm reset and logging functions.

The software can be used to initiate a number of responses to an alarm condition, including automatic calling or beeping of service personnel and sending of fax messages incorporating the latest data. The program can also automatically initiate a logging function at a predetermined time and at any desired sampling rate.

The system with the data storage option allows as much as six months worth of data to be stored in order to develop trend studies and statistical analyses. The data can be displayed in tabular or graphical formats, and can be used to profile changes in performance over frequency or time. It is this ability to view performance over time that offers the system operator the ability to spot gradual degradation, which can lead to failure. Even a change from one day to the next can signal that an event took place that requires attention.

## Simple test, big results

VSWR is such a basic measurement that its potential use for service providers is often overlooked. Simply stated, when VSWR goes up, performance, customer satisfaction and, ultimately, profits go down. VSWR measurements, whether conducted manually or with sophisticated automated equipment, can go far toward keeping communications systems performing well without catastrophic failures.



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# Installation tips for heavy equipment

*Building your own mounting plate, placing the radio near the operator, using a power buss and taking care in antenna mounting will ensure a successful installation in a road grader and other types of construction vehicles.*

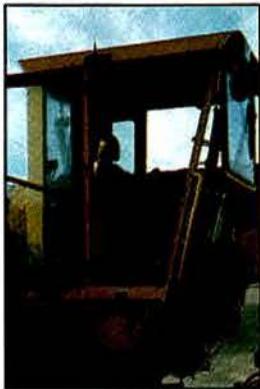


Photo 1. Grader cabs are mostly glass, presenting installers an opportunity to show how clever they can be.



Photo 2. The radio and control head are mounted on plate attached to cab risers next to the operator seat in the grader cab.



Photo 3. Use magnetic switches in power lines to protect equipment.

By Donald E. Koehler

Installing radios in heavy equipment can be straightforward and relatively trouble-free if the installation technician plans ahead, talks with the operator and follows some simple tips. The planning required usually is minimal, including checking equipment system battery voltages and potential mount locations. For example, let's focus on one type of equipment, a road grader (motor blade), to explore some different installation options.

The grader in this example is used in snow removal and general maintenance work at a large airport. This operating location requires the grader to have a VHF FM land mobile radio, a VHF AM aircraft band radio and a strobe light that operates continually while the engine runs. The operator cab is almost entirely glass and is filled with control lines and levers. (See Photo 1 above left.)

Mounting the radio equipment on the cab's ceiling is ruled out because some of

the equipment operators are short and would find it difficult to reach the controls safely for adjustment. Floor space is almost non-existent, and the seat is spring-mounted for operator comfort. These limitations are not too uncommon, yet the installation is not difficult when steps are taken in this order: first, the radio mount; then, the interconnect wiring; and finally, the antenna mount.

Having ruled out the cab's ceiling and floor as radio mount positions and with the cab walls being made mostly of glass, it becomes necessary to build a mount location. On the right and left sides of the operator's seat, measure the distance between the risers (roof supports). Then measure the length of the radio set to be installed. To create a place to mount the R/T unit, we will build and attach a plate on the risers. From mild steel or rigid aluminum plate, cut a section of metal wide enough to span cab risers and to support the radio mount. Paint both sides to improve its appearance and to retard corrosion. Attach the plate to the cab risers with

large sheet metal screws. Use at least three on each side if a radio mount will be attached to the plate. Use more screws if the plate itself will hold the R/T unit. (See Photo 2 at the left.)

To hold the plate while drilling screw mount holes (I drill the plate and riser at the same time), use double-sided tape to hold the plate in place. Then remove the plate and attach the radio mount to the plate. Using the tape allows you to check the fit of the radio mount quickly before finally fastening it in place. When you are sure everything fits, screw in the mount and plate, and then attach the R/T unit.

Route the wiring down and behind the operator's seat. Use tie-wraps or cable loops to hold the wires away from pinch points under the seat or where the operators place their feet. Feeding the power supply wires into the battery compartment is fairly simple. Take the time to use a magnetic switch or low-voltage cutout switch in-line to protect your equipment. (See Photo 3 above right.) If you are installing multiple radios, take the time to pull a "buss" wire from the battery supply, bring the radio power wires to a screw block and tie them together. This will simplify troubleshooting and future equipment installations.

If you must route wires through any bulkheads, use a rubber grommet to protect the wiring. To seal the grommet, room-temperature vulcanizing (RTV) caulk may be used safely if bare metal is not exposed to the acid excreted by the RTV while curing. Avoid splices near the battery compartment, and use heat-shrink tubing to protect any other splices. When shrinking this type of tubing, use a heat gun. A flame or other open heat source is not safe. Where space is tight, liquid vinyl

Koehler is the owner of Communication Specialties, Anchorage, AK.



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 **Larsen**

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**Photo 4.** Mount speakers on roof, but check often for safety's sake.

may be used to protect splices. Avoid using liquid vinyl in high-temperature areas, and always ensure good ventilation during application.

If the radio set requires a control head, use another plate and mount it on the other side of the cab. Use common sense and care in wiring. When aircraft band and land mobile radios are installed in the same vehicle, it usually is necessary to install a filter to reduce interference between the sets. Because of their light weight, speakers can be safely mounted on the risers to be near the operator's head or on the cab's ceiling. As with any equipment mounted where it will be overhead, check the mounts at least as frequently as you check the an-



**Photo 5.** Simple L-shaped mounts.

tenna system. (See Photo 4 above left.)

#### Speaking of antennas...

If strobe lights are roof-mounted or if the grader will be used near overhead obstructions, consider building a mount to hold the antenna to the side of the operator cab roof. A simple L-shaped bracket attached to the side or rear of the cab is adequate in most situations. If you mount antenna brackets on opposite sides of the cab, it will help to reduce interaction between the land mobile radio and aircraft band radio systems. (See Photo 5 above.)

Using the engine deck, or motor hood, as



**Photo 6.** Connect cables to antennas along protected routes.

an antenna mounting point, even with diesel powered machines, is not a good idea. Vibration and heat will soon cause trouble in antenna systems and cables. Antenna cables can be routed near cab windows to avoid obstructing the operator's vision. Be careful that the power and antenna cables are not pinched between the cab and engine housing. (See Photo 6 above.)

Building your own mounting plate, placing the radio near the operator, using a power buss and taking care in antenna mounting will ensure a successful installation. These installation suggestions apply to other types of heavy equipment with operator cabs. If the equipment is not provided with a cab, similar methods will work. The difference would be that the R/T unit is placed in a weatherproof box or is protected by a weather hood.

#### Acknowledgments

Thanks to Anchorage International Airport and Tom Eral, Bobbie Frisby, Rich Hittle and the rest of the professional operating crew all working to make our lives safer.

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[092]

# Paging technology: Flex, ERMES paging codes

*Part 3—ERMES takes Europe, and Motorola's Flex (in one form or another) takes the rest of the world in the contest to roll out a faster paging protocol.*

*Data rates as high as 6,400bps are achieved on a paging channel.*

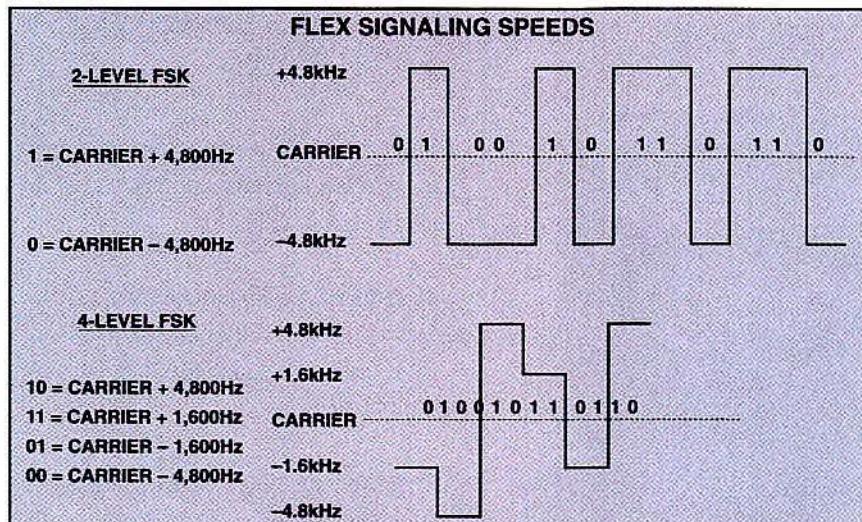


Figure 1. Here are the differences between 2-level and 4-level frequency-shift keying (FSK) modulation. Note that for 4-level FSK, each two-bit sequence, known as a symbol, is represented by a level. Using the same rate of transmission, the bit rate can be doubled. In other words, if the top example is 1,600bps, then the bottom example is 3,200 bps; nevertheless, the bit rate of the top example is the same as the symbol rate of the bottom example.

By Lynne Stewart

Motorola's flexible wide-area synchronous protocol (Flex) is being used in several cities in the United States. Also, many service providers in the Far East are planning to install the Flex protocol, including China, Indonesia, Singapore, Thailand and Japan (RCR-43).

For other companies to have the right to implement the Flex protocol in their products, they must first receive a license from Motorola. At the time of the Flex protocol's announcement (June 1993), NEC America, Fort Worth, TX, was licensed to build Flex paging products, and Glenayre Technologies, Charlotte, NC, was licensed to manufacture Flex infrastructure.

The Flex protocol offers several advantages. One is a significantly long battery life compared to POCSAG pagers. Extended battery life makes smaller pagers with smaller batteries possible.

A user also may notice improved message integrity because of the Flex protocol's error-correction capability. Other user benefits will come from the expanded services that the Flex protocol will provide, including

- nationwide paging.
- missed message indication.
- efficient dynamic group calling.
- information services.
- computer file transfers.

The service provider benefits because the Flex protocol can serve more subscribers per transmitter than any other paging protocol—four times the current maximum number of pagers on an RF channel. The protocol's interleaving of address and

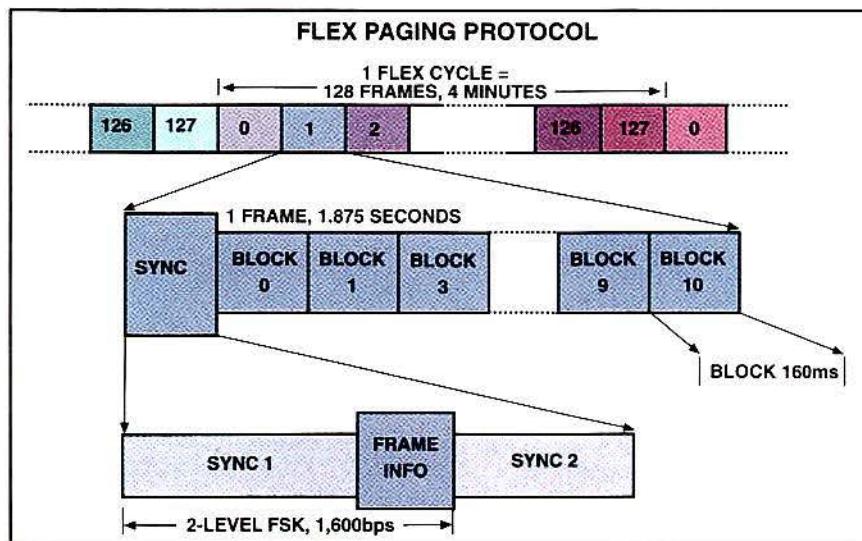
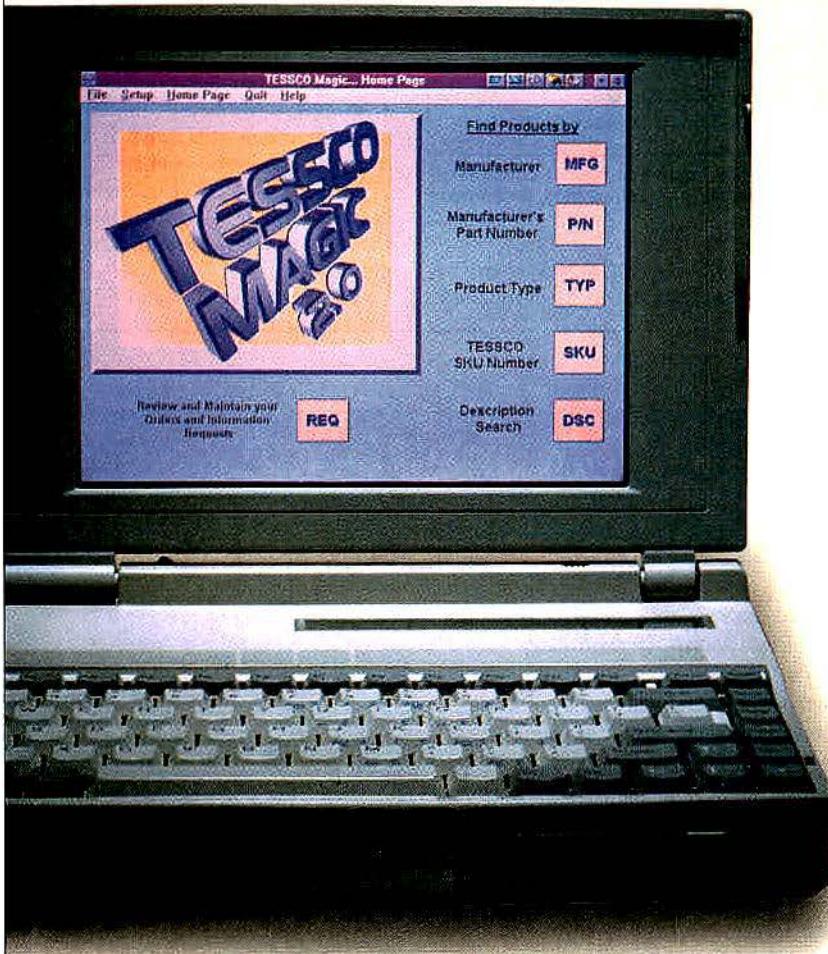


Figure 2. A four-minute Flex cycle is further divided into 128 frames, each with a sync field and 11 blocks.

Stewart is a market development manager with Hewlett-Packard's Microwave Instruments Division, Santa Rosa, CA.

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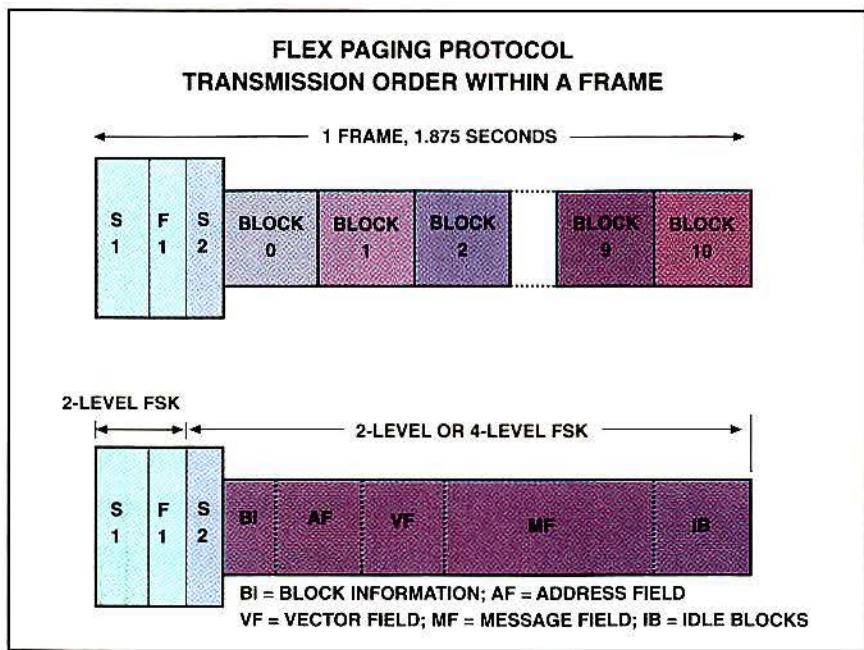


Figure 3. Information transmitted within a Flex frame includes fields that are not constrained by block boundaries. Fields transmitted in a frame are a block information field, an address field, a vector field, a message field and idle blocks.

message bits provide fade protection. The Flex protocol also can be added to

existing POCSAG or Golay systems because it was designed to be compatible.

The Flex protocol can be transmitted at three different speeds: 1,600bps, 3,200bps or 6,400bps. Flex pagers can operate at any of the three speeds. In fact, they automatically decode the correct signaling speed based on information from the paging signal. The 2-level frequency-shift keying (FSK) modulation, as used for POCSAG and Golay, is used for the slowest transmission, 1,600 bps. The 6,400bps transmission uses 4-level FSK. The 3,200bps transmission may be transmitted at either 2-level or 4-level FSK.

Figure 1 on page 22 shows the differences between 2-level and 4-level FSK. Note that for 4-level FSK, each two-bit sequence, known as a symbol, is represented by a level. Using the same rate of transmission, the bit rate can be doubled. In other words, if the top example is 1,600bps, then the bottom example is 3,200 bps; nevertheless, the bit rate of the top example is the same as the symbol rate of the bottom example.

The Flex protocol is a synchronous code that assigns pagers to frames. These frames occur at a rate of 128 every four minutes.

One Flex cycle equals 128 frames.

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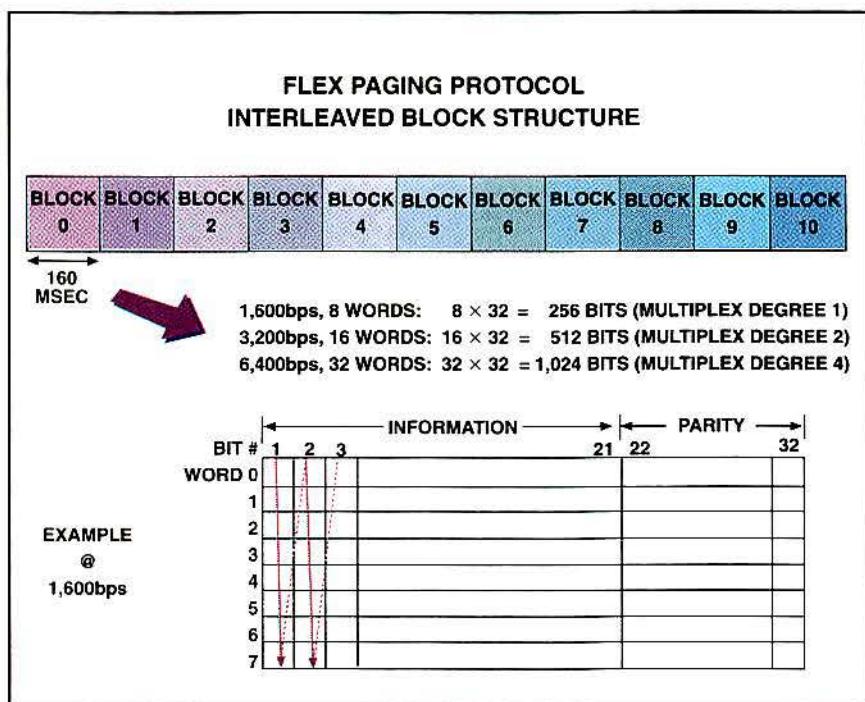


Figure 4. The Flex protocol's interleaved block structure can be seen from the 1,600bps example above. Eight codewords, arranged in rows, are transmitted by columns forming a 256-bit block. Two bit-error corrections per codeword result in the capability to correct a 16-bit error burst on the channel: 16 bits/1,600bps = 10ms.

There are 15 Flex cycles per hour. (See Figure 2 on page 22.)

Each pager is assigned to look at a particular frame (or frames) within a Flex cycle. Upon "power on," the pager determines the time of its assigned frame(s) and only turns on its receiver circuitry during that time. This function improves the pager's battery life because it eliminates the need for preamble detection. The frame assignment for a pager is configured in the pager or determined from information within the paging signal.

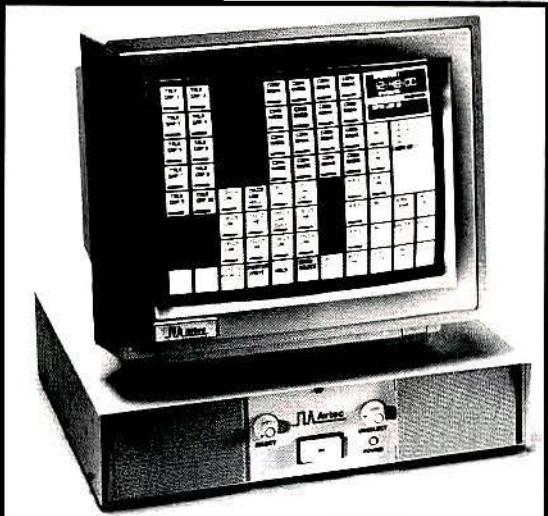
Each frame consists of a sync field and 11 blocks. A frame is 1.875 seconds.

The sync information takes 115ms to send and is composed of three parts:

- sync 1.
- frame information.
- sync 2.

The first two parts are always transmitted at 1,600bps using 2-level FSK. Sync 1 provides timing information and indicates the speed of the rest of the frame. The frame information word contains the frame number (0-127), the cycle number (0-14) and other information. Sync 2 provides synchronization at the frame's block speed so the remainder of the frame can be properly decoded.

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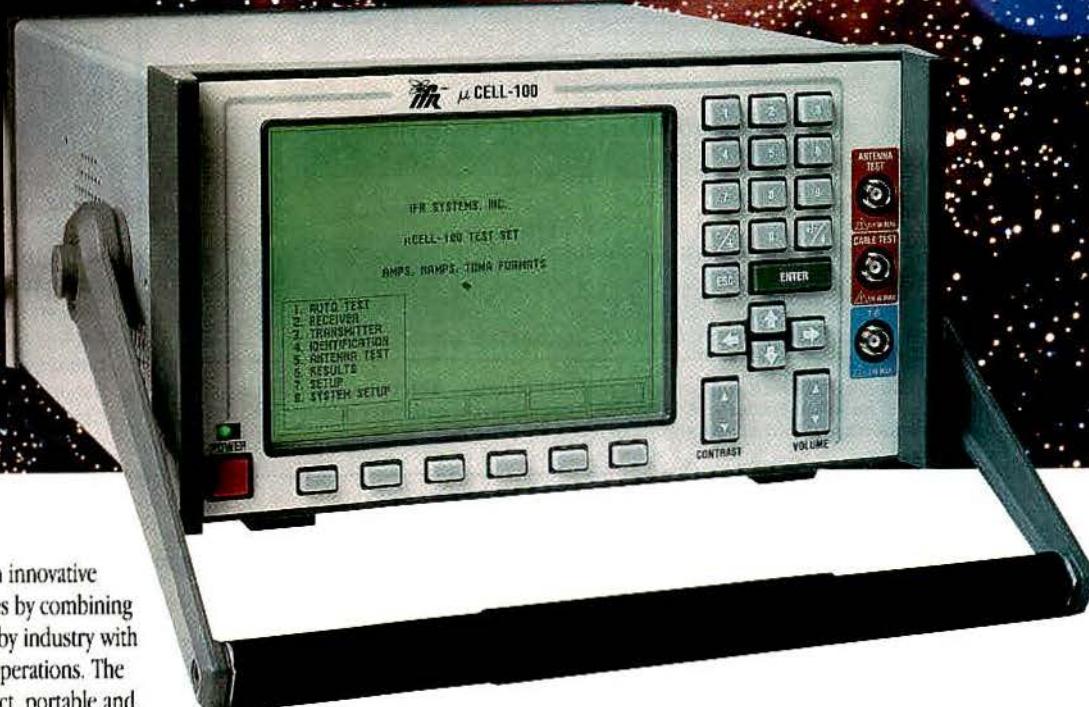
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- Results mode to view test results or output data to printer.

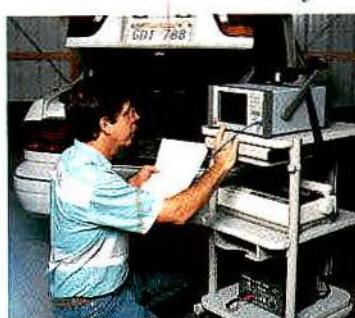
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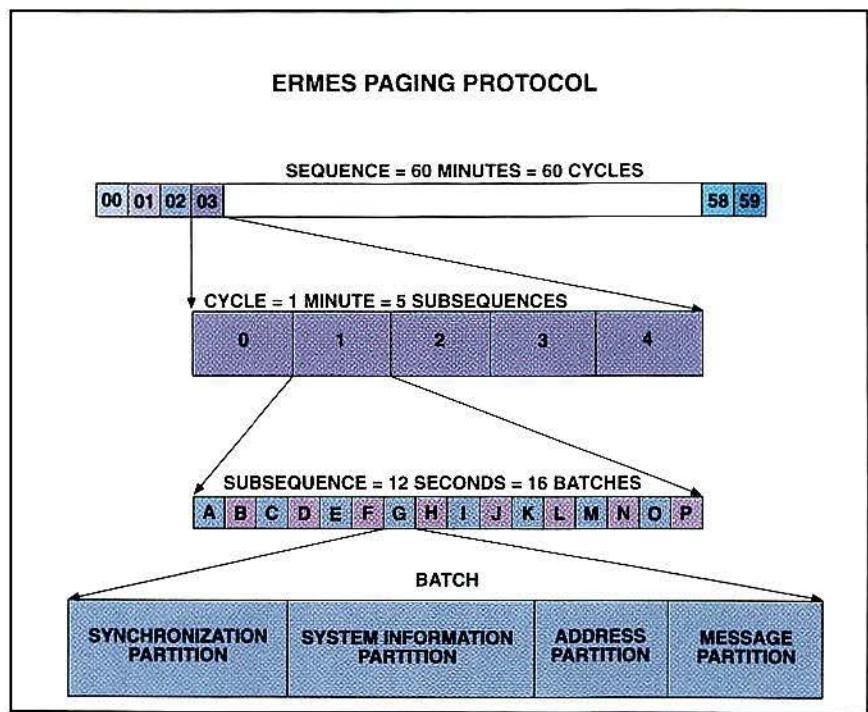


Figure 5. The basic ERMES transmission protocol structure includes a sequence of 60 cycles that lasts 60 minutes. Each cycle is called a *paging cycle* and lasts one minute. Cycles are further divided as shown above and as discussed in the text.

There are 11 blocks, and each is 160ms long.

The information that is transmitted within a Flex frame is shown in Figure 3 on page 24. The fields are not constrained by block boundaries. The fields that are transmitted in a frame are a block information field, an address field, a vector field, a message field and idle blocks.

The block information field is typically one word long and contains information that indicates where in the frame the address and vector fields start, frame information from the system as discussed above and how many priority addresses are placed at the beginning of the field. Priority addresses are assigned to pages with an "urgent" priority.

The address field contains addresses of the pagers that are being paged during this frame time.

The vector field has a one-to-one relationship with the address field, so the pager knows where to look for the vector. The vector points to the start word of the message and indicates the length of the message, again so the pager knows where the message occurs. Of course, the message field contains the message information for the pager.

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Any unused blocks in a frame are filled with bits representing idle-alternating ones and zeros at 1,600bps. At higher speeds, the symbols must represent that same pattern at 1,600bps.

The Flex protocol's interleaved block structure can be seen from the 1,600bps example in Figure 4 on page 26. Eight codewords, arranged in rows, are transmitted by columns forming a 256-bit block. Two bit-error corrections per codeword result in the capability to correct a 16-bit error burst on the channel: 16 bits/1,600bps = 10ms.

*ERMES is intended to be the European-wide standard for radiopaging services, which means that subscribers can be paged outside their home country.*

For a 3,200bps transmission, the block structure consists of 16 codewords. These 16 codewords, arranged in rows, are transmitted by columns forming a 512-bit block. Again, with two bit-error corrections per codeword, the protocol can be used to correct a 32-bit error burst on the channel in 10ms. Similarly, for 6,400bps transmission, the block size is 1,024 bits and the protocol can be used to correct a 64-bit error burst.

#### ERMES

The European Radio Message System (ERMES) is a paging protocol defined in a standard published by the European Telecommunications Standards Institute (ETSI). ERMES is intended to be the European-wide standard for radiopaging services, which means that subscribers can be paged outside their home country. ERMES, as is Motorola Flex protocol, is a more complex format than POCSAG or Golay sequential code.\*

ERMES has many advantages over the

\*Flex is short for flexible wide-area synchronous protocol.

ERMES stands for European radio message system.

POCSAG stands for Post Office Code Standardisation Advisory Group.

Golay sequential code is named after Marcel Jules Edouard Golay (b. 1902), a physicist who constructed the code about 1955.



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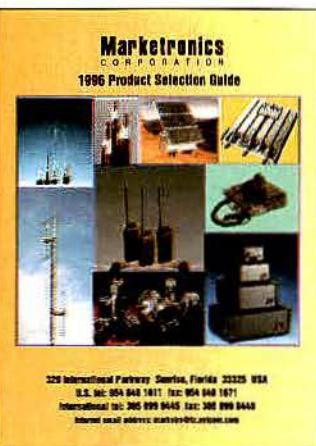
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existing POCSAG systems in Europe. It operates in a frequency range that is common throughout Europe. This commonality allows the use of standardized receivers. Moreover, the network is compatible from country to country, so subscribers may roam throughout Europe and still receive pages.

The use of 4-level FSK modulation allows data transmission at 6,250bps with no trade-off in data integrity. With batch transmission techniques, the battery life of a pager is prolonged, because the pager only receives messages in one of 16 batches. In addition, pagers scan as many as 16 RF channels. This scanning allows a network operator to change system operating frequencies as necessary to meet capacity requirements without having to modify pagers.

The structure of the basic ERMES transmission protocol is shown in Figure 5 on page 28. A sequence of 60 cycles lasts 60 minutes. Each cycle is called a *paging cycle* and lasts one minute. The paging cycle is divided into five *subsequences*, each lasting 12 seconds or less. Each subsequence is further divided into 16 *batches*, labeled *A* through *P*. The pager population is divided into 16 *groups*, each being allocated to one of the 16 batches.

Codeword interleaving occurs in the message partition. Interleaving to a depth of nine codewords is specified. Each message codeword is 30 bits long, including 18 information bits and 12 parity bits.

Next month: How pagers are developed and tested to ensure good performance in the field.

## Paging technology series

Part 1: "Systems and Services," February 1996.

Part 2: "POCSAG, Golay Paging Codes," March 1996.

Part 3: "Flex, ERMES Paging Codes," April 1996

Back issues printed within the past two years can be ordered for \$5 each, postpaid. Call Intertec Publishing customer service at 800-441-0294. Issues printed more than two years ago and individual article photocopies are unavailable from the publisher. Individual photocopies of articles printed since January 1983 can be ordered from UMI Information Store, 800-248-0360.

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# EXPO SHOW SECTION

## IWCE show preview/guide

Welcome to *Mobile Radio Technology's* pre-show coverage of the 1996 International Wireless Communications Expo. This year witnesses two landmarks, as the show celebrates its 20th anniversary and *Mobile Radio Technology* becomes the official publication of the show. Our editors have worked to provide a comprehensive overview of this annual mobile communications show. This section is designed to help you to plan your time at the Las Vegas Convention Center, Las Vegas, April 24-26. Sections include:

□ a pull-out map on page 32A, including a list of exhibitors and their booth numbers.

□ a summary of exhibitors' products and services on display. Exhibitors listed include those who submitted information as of press time.

More than 350 mobile communications equipment manufacturers, distributors and service providers will convene at the Las Vegas Convention Center, and many exhibitors will debut new products and services as they gear up for 1996. Products on display will include antennas, accessories, cellular

items, data communications, lightning protection equipment, mobile and portable radios, paging equipment, tone signaling equipment, towers and other wireless-related items.

For a rundown on what exhibitors plan to unveil and showcase at this year's Expo, refer to the **Products and Services** section beginning on page 33. The names of exhibitors who are also advertisers in this issue are highlighted in blue ink. Page numbers indicating where you can find their respective advertising are also listed.

In addition to the new products that exhibitors will display individually, there will be a "New Products Information Center" where visitors can review new products and new product literature. This year an RF technology pavilion is also included on the exhibit floor, featuring the latest in design elements and subcomponents. Symposia at Expo will cover mobile communications industry opportunities and technical topics (see below). *Mobile Radio Technology* will be in Booth 819.

See you at Expo!



### IWCE Symposia Schedule

#### Wednesday, April 24

- Opening session: What is the Future Role of the Land Mobile Provider?
- Implementing Refarming: A Technical Overview
- The APCO 25 Experience: How the User Speaks
- Advanced Grounding for Total Equipment Protection
- The State of Regulation in Latin America
- The Future of Global Private Radio: Forecasting International Market Growth
- The 800MHz SMR Transformation
- Dealers and Manufacturers Information Exchange

#### Thursday, April 25

- Washington Roundtable
- FCC Open Forum
- Marketing Strategies for Narrowband Deployment
- Coping with 800MHz SMR Changes
- Wireless Local Loop
- Emerging Technologies
- The Regulatory Landscape: A Global View
- International and Regional Agreements in Latin America
- Number Portability
- Making the Most of Tower Sites and Structures for Mobile Communications
- Being a Good RF Neighbor
- Testing Motorola Pagers

#### Friday, April 26

- Paging Technology Update
- FCC Auction Update
- Integrating Mobile Data into Your Wireless Network
- Closing Session: Future Directions in Wireless Communications Businesses

### RF design Seminar Series

Runs concurrently with IWCE Symposia  
Tuesday, April 23, 8 a.m. to 5 p.m.  
Wednesday, April 24, 8 a.m. to 5 p.m.  
Thursday, April 25, 8 a.m. to 5 p.m.

**Event:** International Wireless Communications Expo  
**Dates:** April 24-26, 1996  
**Location:** Las Vegas Convention Center  
**City:** Las Vegas  
**Number of Exhibitors:** More than 350  
**Projected Attendance:** 9,000

**Exhibit Hours:** Wednesday, April 26, 10 a.m. to 6 p.m.  
Thursday, April 27, 9 a.m. to 6 p.m.  
Friday, April 28, 9 a.m. to 2 p.m.

**Registration/Hotel Information:**  
Intertec Presentations, 800-828-0420

# Products, services

**Information for listings and booth numbers is accurate as of press time and is subject to change.**

**A.W. Enterprises** **Booth 252**

*Existing products*

Carrying cases and accessories for two-way radios, pagers and miscellaneous electronic equipment.

*New products*

Cordura nylon cases for two-way radios.

**Circle 201**

**Accele Electronics** **Booth 559**

*New products*

VP100 cellular vibrating pen; 911ORF wireless automatic car radio mute; MR850 high-capacity battery with built-in voice recorder; HF300 hands-free kit for Motorola phones.

**Circle 202**

**See classified ads**

**Advance Label & Tag** **Booth 1840**

*Existing products*

Logo labels and nameplates for pagers, cellular phones and radios; specialized labeling for batteries, antennas; bar-code; bar-code printers and accessories; printing software.

*New products*

Deco-Fone decals that customize and colorize cellular phones.

**Circle 203**

**See classified ads**

**Aerotron-Repo Systems** **Booth 1126**

*Existing products*

RDL-series transmitter & receiver telemetry radio links; Econolink RS-232 FSK modem; synthesized MPAC base-repeater station; utility data system; SLR-96 and SLQ-96 bps RS-232-compatible modem.

*New products*

NLR-series spread-spectrum RF modems, including transparent, point-to-point and point-to-multipoint, 900MHz and 2.4GHz.

**Circle 204**

**Comm** **Booth 1412**

*Existing products*

Reconditioned two-way mobile, base and portable radios and accessories; "PL" and paging reeds and filters.

**Circle 205**

**See classified ads**

**Alexander Batteries** **Booth 620**

*Existing products*

Batteries manufactured for the two-way communications, cellular telephone and laptop computer industries, as well as battery systems for original equipment manufacturers; battery maintenance equipment, such as the Optimizer and Personal Smart Charger.

*New products*

The Optimizer 2000 series self-contained battery maintenance system that charges NiCd, NiMH, lead acid and specific Lithium batteries; optional computer interface and software.

**Circle 206**

**See ad page 45**

**Allen Telecom Group** **Booth 1427**

*Existing products*

dB Director; DB 840 series; log periodic dipole array; PCS panel antennas; Pagetracker Pro; Cell Scope Pro; Spectrum Tracker; vehicular land mobile, trunking and cellular antennas.

*New products*

Diversity Master DB 850 series; DB 8062 F series trunking transmitter combiner; DBA73A7P05 series Autotrunk automatic tuning combiner; AutoPage automatic tuning paging combiner; Mosaic vehicular land mobile antennas.

**Circle 207**

**See ad IFC**

**American Tower Services** **Booth 1457**

*Existing products*

Communication tower erector; transport prefabricated concrete building.

*New products*

GFRC shelters; prefabricated concrete buildings.

**Circle 208**

**See ad IFC**

**Andrew** **Booth 1401**

*Existing products*

Terrestrial microwave, cellular, PCS, earth station antennas; coaxial cable and waveguide; towers; shelters; in-building signal solutions; program management; delivery and installation; inspection services.

*New products*

½" and ¾" high-power/high-temperature Heliax Star Cable; ¼" Heliax cable assemblies; ⅛" Heliax connectors; N and DIN interfaces for Superflexible cable; KPA series Gridpak antennas; EFX2-50 Extra-Flexible LDF Heliax cable; captivated LDF5 connectors; updated versions of planning and installation software; Arrestorport Plus premium surge arrestor assemblies.

**Circle 209**

**See 64A-B**

**Anritsu Wiltron** **Booth 659**

*Existing products*

MS 2602A spectrum analyzer; MS 8604A digital mobile radio transmitter tester; 54169A network analyzer.

*New products*

MS 2661A spectrum analyzer; MG 3660A digital modulation signal generator; Site Master 5331 antenna system tester; 37300A Vector network analyzer; 69000A synthesized signal generator; MG 3671A digital modulation signal generator.

**Circle 210**

**See ad page 45**

**Antenex**

**Booth 1426**

*Existing products*

Mobile, portable and base antennas for two-way communications; mounting kits; cable kits; custom cable assemblies.

*New products*

Voyager aluminum base antennas; 7dB UHF fiberglass base antennas; wideband mobiles—lowband, VHF, UHF models; Silver series yagi antennas.

**Circle 211**

**See classified ads**

**Antennaco**

**Booth 358**

*Existing products*

Directional antennas (460MHz and 928MHz); hemispherical antennas for cellular, wireless PBX.

*New products*

P-2400 2.4GHz directional antennas; P-1900 1.9GHz directional antennas.

**Circle 212**

**Associates Leasing**

**Booth 354**

*Existing products*

Leasing and financing of communications equipment.

**Circle 213**

**Astron**

**Booth 1640**

*Existing products*

Power supplies; inverters; converters; battery chargers.

**Circle 214**

**See ad page 7**

**Atlantic Solar**

**Booth 1247**

*Existing products*

Packaged solar electric power systems.

**Circle 215**

**AVCOM of Virginia**

**Booth 830**

*Existing products*

PSA-65A, PSA-35A, PSA-37D portable spectrum analyzers; MSG-1000B, MSG-5, MSG-1750A microwave/RF sweep-signal generators; NSA-100A network and spectrum analyzers; RLB-1000-50, RLB-1000-75, RLB-1300-50 return loss bridges; microwave video links; SCS, SCPC, video, INMARSAT satellite receivers; microwave accessories.

*New products*

PSA-65B portable spectrum analyzers; SCPC-1000D SCPC satellite receiver; MRST-1500D INMARSAT receiver; RLB-1000-50, RLB-1300-50 50V return loss bridges; RLB-1000-75 75V return loss bridge.

**Circle 216**

**See ad page 96**

**Avtec**

**Booth 240**

*Existing products*

DSPatch color touchscreen, mouse-operated integrated radio/telephone console system with control of conventional and trunked radio; PBX, ARD, PSTN lines; intercom and special circuits; multi-format paging; supports

## Expo

32-1,024 ports.

### New products

DSPatch32 has all features of DSPatch in a smaller, more affordable platform.

Circle 217

See ad page 26

Ball

### Existing products

MetroView automatic vehicle and incident location and status display.

Circle 218

Booth 1859

### Band-It, Idec

#### Existing products

Band-It toolless tie; MultiLok; TieLok; UltraLok stainless-steel cable ties; identification tagging; pneumatic and hand tools.

Circle 219

Booth 1861

### New products

ProTalk RFX low-power site monitor; B1658

RF power monitor.

Circle 220

Booth 1658

### BearCom

#### Existing products

Radius portables, mobiles and base stations.

Circle 221

Booth 636

### Bee Electronics

#### Existing products

Leather and Durus cases for two-way radio, cellular phones and pagers.

### New products

Durus cellular phone cases; spring-steel clip option for all models.

Circle 222

Booth 131

### Benelec

#### Existing products

VHF and UHF base station antennas, Discone base antennas; VHF, UHF and cellular mobile antennas and fittings; speakers and microphones; 24Vdc-12Vdc voltage reducers; 19" rack-mounted battery management power supplies.

### New products

093115 15A, 19" rack-mounted power supply with full battery management.

Circle 223

Booth 217

### Berry Controls

#### Existing products

SCADA systems and software.

Circle 224

Booth 629

### Bird Electronic

#### Existing products

Vintage model 43 Thruline wattmeter in service since early 1950s; Thruline wattmeters; hand-held cellular antenna tester.

### New products

HF antenna tester; VHF and UHF antenna tester; full line of coaxial terminations and attenuators.

Circle 225

See ad page

Booth 701

### BK Radio

#### Existing products

VHF portables and mobiles; EC series Jerk-n-Run units; dual transceiver mobiles; signaling devices; full line of accessories.

### New products

EC series Jerk-n-Run units: ECH590, ECH590JS, ECC510J1, ECC510JS, ECU490JA, ECU490JS; LAA0170 120V/240V power supply.

Circle 226

See ad pages 36, 37

Booth 347

### Brown and Schwaninger

#### Existing products

Form 600 Made Painless.

Circle 227

Booth 2047

### Buy-Comm-Co

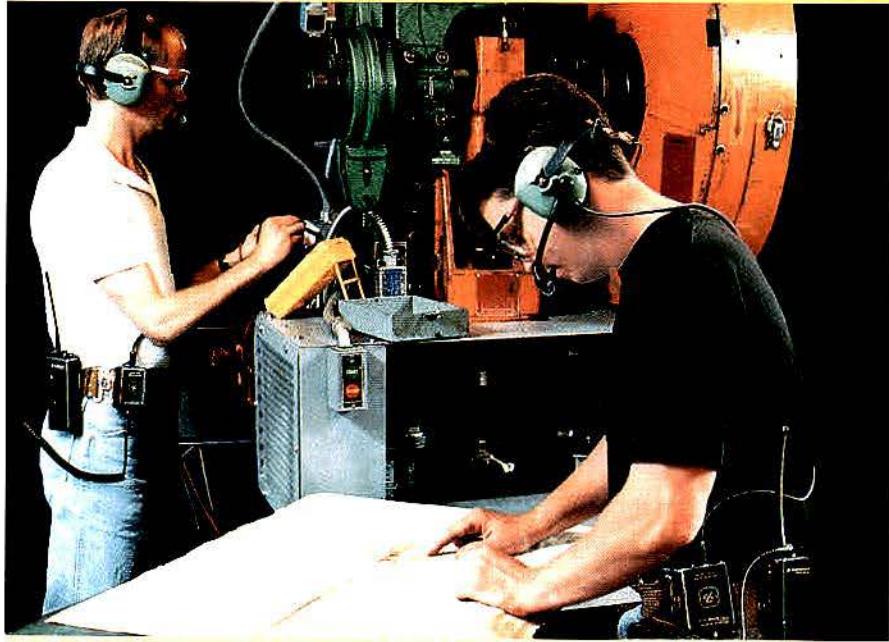
#### Existing products

Wanted new and used radio equipment—Motorola, E.F. Johnson, Standard, Kenwood, Uniden; repeaters and paging transmitters.

Circle 228

See classified ads

## Improve PRODUCTIVITY and SAFETY.



### Problem:

Excessive background noise on the plant floor.

When production machinery needed maintenance or repair, craftsmen working within a few feet of one another could barely communicate. They often had to leave the floor to discuss the repair between themselves.

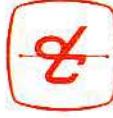
### Solution:

A Noise-Attenuating Headset System.

The headset and radio adapter, **when combined with a two-way radio**, completes a unique communication system. Maintenance personnel can communicate with each other while working on production machinery and talk to people outside the work area. The electrical department also uses the system for installations and pulling wires. "There's no more yelling back and forth."

In addition to the obvious benefits such as less downtime and increased efficiency, the headset system has contributed significantly to overall worker safety.

**Call for a FREE demonstration in your plant or work site.**



**David Clark COMPANY**  
INCORPORATED

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TEL: (508) 751-5800

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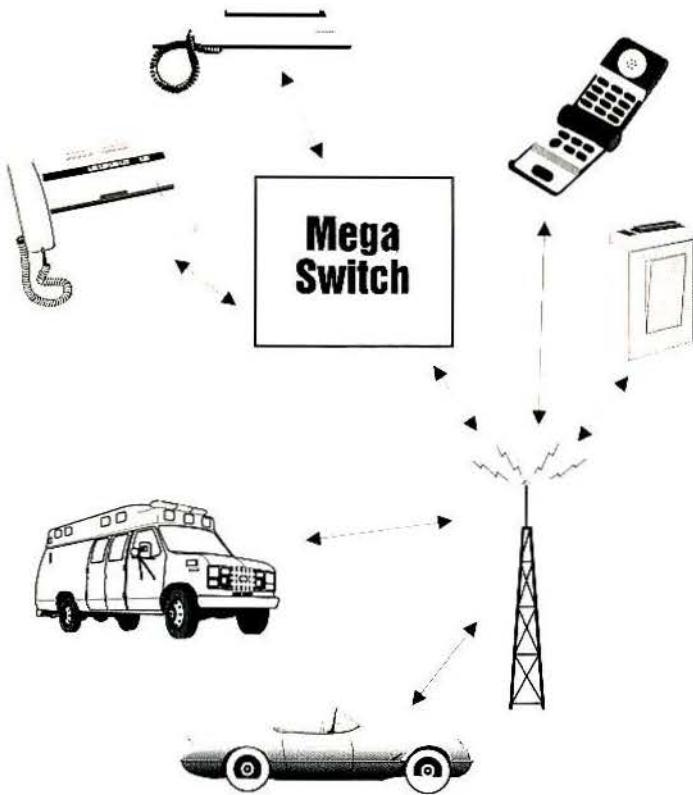
Visit us at IWCE, Booth #1925.

Circle (29) on Fast Fact Card



## **SMR Enhancements & Networking**

- Digital Audio
- Start With 48 Ports Increase To 256
- Follow Me Roaming
- Time Steering
- No Answer Transfer
- Remote Subscriber Rerouting
- Remote System Access
- Real Time Diagnostic Displays
- Voice Mail
- Call Screening
- Least Call Routing



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## Expo

C.E.T.

*Existing products*

Airsite propagation study software; CET3500 3-dimensional terrain viewer; "Dial Access" on-line services.

**Circle 229**

**Cablewave Systems**

**Booth 1853**

*Existing products*

Flexwell foam coaxial cable; Type N and DIN coaxial connectors; microwave antennas.

**Circle 230**

**Cadex Electronics**

*Existing products*

C7000 battery analyzer services NiCd, NiMH, SLA and L-ion batteries.

*New products*

C7000ER, based on the C7000 platform, the ER offers 150W of continuous power; BatteryStat is a Windows-based application software that interfaces with a PC to collect battery data from the analyzers; BatteryNet networks as many as 32 C7000 analyzers through an RS-485 bus for si-

**Booth 348**

multaneous service of 128 batteries.

**Circle 231**

*See ad page 14*

**Cartwright Communications**

**Booth 417**

*Existing products*

Andrew, Cablewave, Allen Telecom Group, Celwave, CESCO, Telewave, Federal Signal, PolyPhaser, Bird, Gamber-Johnson, Alexander, Multiplier, Speco, Times LMR, Astron, RFI Connectors, Amphenol, Newmar, Communications Specialists, SmarTrunk Systems and SSC.

*New products*

Expanded engineering—site equipment; rental service; retune equipment; special filter design; phasing harnesses; expanded export services.

**Circle 232**

*See ad page 98*

**Cellular & Mobile International**

**Booth 819**

*Existing products*

Published bi-monthly, *Cellular & Mobile International* provides decision-makers with articles that examine the technologies, applications and equipment of the international wireless communications industry. The circulation of 10,000+ reaches system operators, dealers, distributors, engineers, large-volume end-users (including public safety buyers) and manufacturers around the world, including European, Asian and Latin American markets.

**Circle 233**

**Cellular Business**

**Booth 819**

*Existing products*

The first and only all-cellular trade publication for the cellular industry, *Cellular Business* is published 13 times a year for cellular system operators, dealers, retailers, resellers, sales agents, distributors, engineers, large-volume end-users and manufacturers. The editorial addresses both technological developments and marketing concerns, with columns focusing on news, new products, sales strategies and data. Visit our booth to pick up a copy and sign up for your free subscription.

**Circle 234**

**Central Tower**

**Booth 459**

*Existing products*

Guyed, self-supporting and monopole communication towers.

*New products*

75' lightning pole for cellular and PCS applications.

**Circle 235**

**Centurion International**

**Booth 719**

*Existing products*

Replacement batteries and antennas for two-way radios and cellular phones; battery and antenna products for wireless data devices and computers; Silent Partner cellular antenna.

*New products*

Enhanced cellular pull-up (ECPU) antennas: ECPU to fit AT&T 3770; ECPU 5706 to fit Nokia 232; ECPU 5707 to fit AT&T 6650 and Nokia 2120; ECPU 5710 to fit JRC 870; ECPU 5711 to fit Nokia 1300 series and model 1335;

# Portable Power!



## The New EC Series

### Vehicular Chargers & RF Amplifiers

The EC Series units are designed to be compatible with Bendix/King portable radios. A specially designed side connector enables a true "jerk & run" operation. Models offered include VHF or

UHF dual rate chargers, VHF and UHF chargers with 50 watts RF amplification across the band and siren and lightbar controls depending on the specific need.

Call today for more information!

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Fax: (913) 841-0287

Circle (31) on Fast Fact Card

# BK WEATHERS THE STORM



The storm is over! And, for our customers who weathered the storm with us -- Thank You! For those of you who couldn't or didn't wait for the rainbow, we invite you to try us again. The long lead times have disappeared into the clouds, and we now have most products in stock for immediate shipment.

We believe the Bendix/King product has been and still is the best buy on the market for your money. There are many products that sell for less and many that sell for more; but the best buy, the best quality, the best warranty and the best features are available from one supplier, and that's BK Radio.

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A RELM COMMUNICATIONS COMPANY



Circle (32) on Fast Fact Card

## Expo

ECPU 5712 to fit Mitsubishi DiamondTel 5000 series.  
**Circle 236**

**See ad page 9**

### CeoTronics

#### Existing products

Headsets and communication systems for radios, including PTT and Vox headsets; Contact Com contact microphone for helmets and respirator masks; Ear mics, covert security systems; TC 917 UHF wireless headset.

**Booth 360**

### New products

Vibrator system for speakerless audio reception; high-performance Superlight headset; modular wireless inductive surveillance system.

**Circle 237**

**See ad page 110**

### Cerulean Technology (formerly

#### PacketCluster Systems)

**Booth 1939**

#### Existing products

Mobile data communications systems for pub-

lic safety; mobile data system with CAD/RMS interface and automatic vehicle location.

### New products

Windows 95-based mobile data communications software for law enforcement.

**Circle 238**

### CESCO (Communication Equipment and Service)

**Booth 4757**

#### Existing products

Universal coax grounding kit; Cable Pak mounting bracket; grounding equipment on tower sites; Safety equipment; stainless and nylon cable ties; skid, track and capstan winches; microwave replacement radomes and hardware; all products for tower sites and maintenance personnel.

### New products

Thermoweld molds and shots.

**Circle 239**

### ChargeGuard

**Booth 457**

#### Existing products

Automatic on/off timer switch for two-way radios and mobile equipment.

### New products

Commshop software designed exclusively for the two-way radio industry to track service information.

**Circle 240**

**See ad page 86**

### Christie Electric

**Booth 246**

#### Existing products

CASP/1200 battery charger and analyzer; CASP/2000 battery charger and analyzer.

**Circle 241**

**See ad page 76**

### Cimarron Technologies

**Booth 130**

#### Existing products

Skymark automatic vehicle location system; GE-Star ANI encoders and decoders.

**Circle 242**

### David Clark

**Booth 1925**

#### Existing products

3000 and 7000 series headsets and push-to-talk adapter cords for mobile and portable radios; 7200 series voice-activated headsets for portable radios; 3800 and 4200 series headset intercom systems with two-way radio interface.

### New products

6000 series noise-attenuating headsets for portable and mobile radios provide clear, crisp voice transmission in high-noise environments.

**Circle 243**

**See ad page 34**

### CommScope—General Instrument

**Booth 1758**

#### New products

Cell Reach broadband coaxial cables designed for wireless transmission systems.

**Circle 244**

**See ad page 63**

### Communications Associates

**Booth 818**

#### Existing products

Uniden portable and mobile VHF, UHF and 800MHz radios.

# THE ULTIMATE POWER TRIP.



When you need power, don't trip up! Demand JBRO land mobile batteries, featuring the industry's highest power ratings. JBRO batteries are built to OEM specifications, without the OEM price tag, so you get dependable, cost-effective performance every time! Then maximize productivity with Telepower® Conditioner/ Analyzers, the finest battery maintenance systems available.

Call today for a free catalog.

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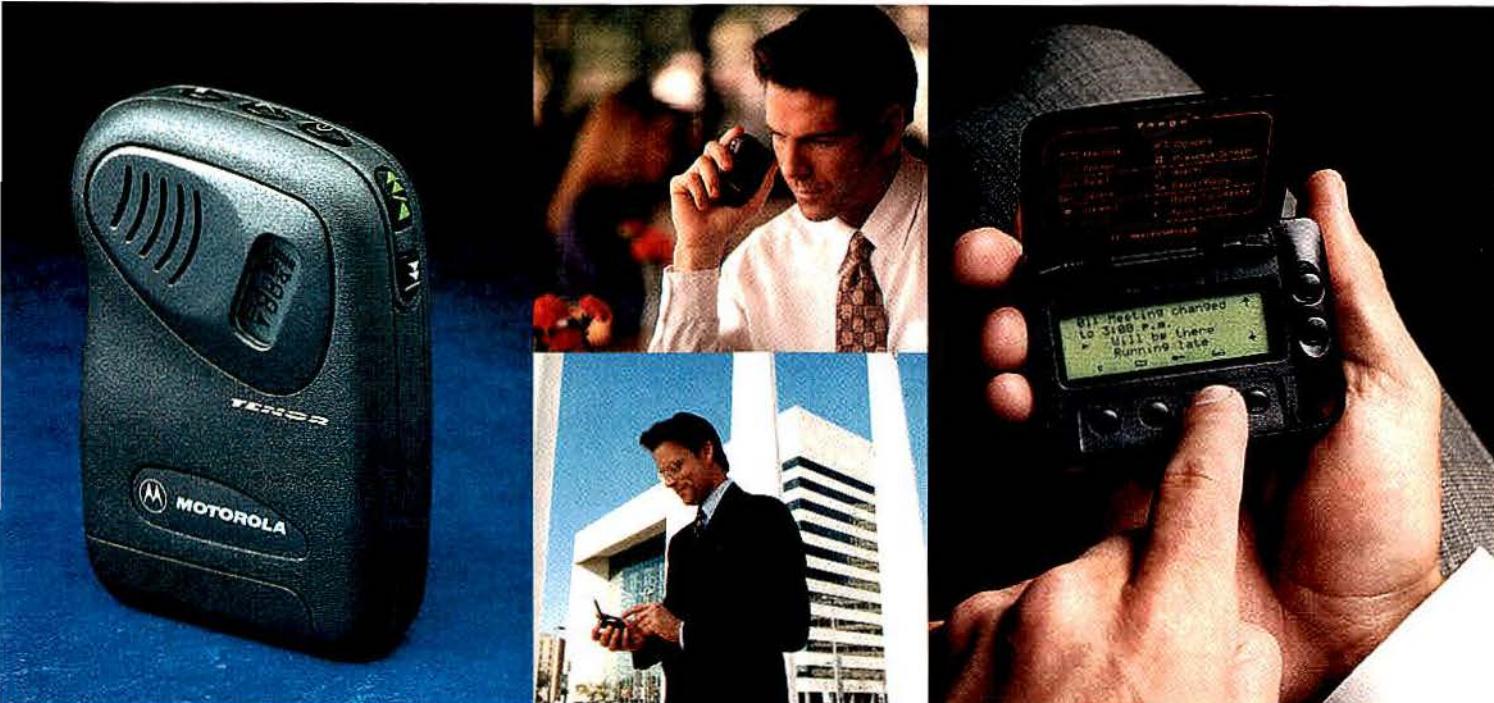
Name Brand Quality. Value priced.



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Circle (33) on Fast Fact Card

# Two-Way Paging Is A Reality!



With the Tango™ and Tenor™ Personal Messaging Units and The Wireless Concert!™ system solution, the very concept of paging expands into a whole new universe of business advantages.

There is a big difference between promises and reality. And today's reality is that Motorola is the first company to offer all the advantages of two-way personal messaging units and advanced messaging systems. At Motorola, two-way messaging is not a promise, it is reality.

Today, with the Tango two-way pager, your customers can reply instantly to a message directly from their personal messaging unit. Or, using Tenor, they can receive, listen

to, and store messages in the caller's actual voice, just like a pocket-sized answering machine. And, for your system, The Wireless Concert! offers many advantages, such as automatic registration, spectrum re-use, assured message delivery, and automatic message-received notification.

To find out more about Motorola's two-way paging products and advanced messaging system solutions, please call us at 1-800-520-PAGE (7243) or (817) 245-4663.



Visit us on The World Wide Web <http://www.mot.com/MIMS/PPG/org/amsd.html>.  
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Circle (34) on Fast Fact Card

## Expo

### New products

IFR's Com-120B; Anritsu Wiltron's S331 Site Master; Uniden's SPS series 800MHz alphanumeric trunking portable phone—SPS335TSD.

Circle 245

### Communications Data Services Booth 729

#### Existing products

Software products and services for radiowave propagation prediction and analy-

sis. RFCad is a Windows-compatible software program incorporating point-to-point, area coverage and contour prediction modules. Results of studies are depicted on color-coded, variable-scale coverage maps. Modifications for the effects of surface clutter and vegetation are available. On-line engineering programs and databases are available remotely via modem, or CDS staff can perform studies in-house.

Circle 246

See classified ads

### Computer Resources

Booth 642

#### Existing products

SMR billing systems; pager billing system; service and sales management; all associated accounting modules; software; hardware; installation and training.

Circle 247

See classified ads

### Comteco Industries

Booth 1259

#### Existing products

BSXL series omnidirectional base station antennas; Y33 series yagi antennas; mobile antennas; mounts and accessories; antenna and antenna system couplers; multiple antenna array products and accessories.

Circle 248

### Connect Systems

Booth 801

#### Existing products

Repeater tone panels; telephone interconnects; communications decoders.

#### New products

LT-4200 LTR controller; LT-4900 LTR controller/interconnect.

Circle 249

See ad page 13

### CPI Communications

Booth 1926

#### Existing products

Dc remotes; dc termination panels; tone remotes; tone termination panels; local extensions and specialty remote control products for use with various Motorola, Radius, Midland and Kenwood radios.

#### New products

MCR210alpha alphanumeric remote for use with Motorola Radius and Maxtrac radios.

Circle 250

See ad page 76

### Cromack Industries

Booth 1948

#### New products

CEC-10A code synthesizer II; CEC-20 code analyzer/synthesizer.

Circle 251

See ad page 84

### CII

Booth 906

#### Existing products

Opti-Page combination voice mail and paging terminal; Page Master Phase II; Mitec-Page (alpha) and Wee-Page paging terminals; SF-65 page store and forward; DID trunk manager; TXC remote base station controller; Mobile Master Phase II mobile terminal.

#### New products

DID/SMR 3-5 features upgrade—now capable of decoding DTMF from DID trunks and can provide a voice prompt to the calling party; also, database back-up capability.

Circle 252

See ad page 98

### Cushcraft

Booth 1135

#### Existing products

Base, mobile and portable antenna products for the land mobile, cellular, PCS, ISM and spread-spectrum radio bands; standard designs are available from 30MHz to 5.7GHz; custom designs and modifications are available upon request.

Circle 253

### D&I Communications

Booth 440

#### Existing products

## It will bring in the clowns.



Digital ANI



**CSC CONTROL SIGNAL®**

1985 S. Depew, #7, Denver, CO 80227  
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**WACOM**  
**QUALITY • SERVICE • PRICE**  
...WE DO IT BETTER!  
FOR THE 150, 450, & 850 MHz BANDS

- \* Low-loss Transmitter Combiners
- \* Receiver Multicoupler Systems
- \* Coaxial Cavity Filters
- \* Duplexers

Investigate this complete line of  
high performance products today!

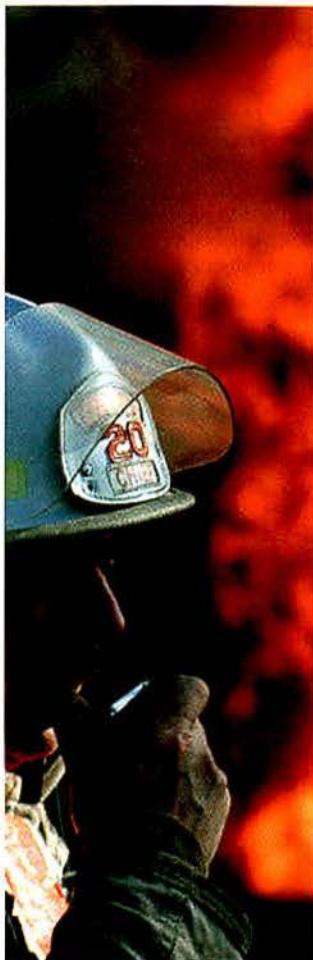
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Circle (36) on Fast Fact Card

# It's Time to Perform.



KENWOOD.  
FIFTY YEARS OF  
ENGINEERING...  
FOR SITUATIONS JUST  
LIKE THIS.

The true test of your 2-way radio is in an emergency situation. This is when you know you can depend on Kenwood. All Kenwood radios are durable, with rugged Mil Spec construction. They're easy to use with convenient and versatile features.

Call us about our TK-230/330 portable with a channel group selector knob for choosing new channels on the fly and enunciator tones so you hear all channel changes. Like our full line of mobiles and portables, the TK 230/330 meets or exceeds military and industry standards in 13 categories. You can feel, hear and see the difference Kenwood makes when it counts.



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Circle (37) on Fast Fact Card

Visit us at IWCE, Booth #401

## Expo

GE two-way radios; EDACS innovations, including the Linker, MDR remote, MDX smart microphone, Extend Orion, Slow Poke power delay timer, Wireless for Windows; wireless data products; AVL/GPS.

New products

Wireless data for EDACS; Telemetry for EDACS; AVL for EDACS.

Circle 254

See classified ads

Daniels Electronics

Booth 245

Existing products

MT-3 synthesized narrowband repeaters; hot/cold standby radio systems; radio modules 118MHz-960MHz.

New products

MT-3 series VHF RX/TX base station radio modules.

Circle 255

Data Express

Booth 1227

Existing products

DE-2400 C RF data modem; fleet management 2000 AVL/mapping software.

New products

DE-2400 G RF data modem with 10-channel on-board GPS receiver; custom software for wireless dispatching and messaging.

Circle 256

Datumtech

Booth 1817

Existing products

Automatic vehicle location and tracking using GPS over RF, cellular and RAM Mobile Data; state-of-the-art dispatch-oriented location and tracking software for public safety, ambulance, trucking and taxi.

New products

AutoGuard-GPS for vehicle anti-theft and roadside emergency assistance; DataLogger-GPS for inexpensive long distance fleet monitoring and data capture; modular mobile computer (MMC) and head-up displays (HUDs).

Circle 257

Dealers' Product Source

Booth 819

Existing products

This tabloid from the publishers of *Mobile Radio Technology* and *Cellular Business* delivers 100% product coverage to a unique audience of wireless communications dealers and retailers. Visit our booth to pick up a copy and sign up for your free subscription.

Circle 258

Diablo Communications

Booth 1243

Existing products

Diablo owns and operates more than 80 multi-user communications sites throughout California and is developing a network of low-elevation sites to complement its established network of mountaintop sites.

Circle 259

See classified ads

DINET

Booth 1855

Existing products

Data-Mate 1000, 1500, 3100 mobile data terminals.

New products

Data-Mate 400, 600, 800 mobile data terminals; AVL/GPS tracking and mapping system.

Circle 260

DuraComm

Booth 117

Existing products

TP series tone and voice pagers; power supplies and related accessories.

New products

LP series desktop power supplies; VP series single-channel voice pagers; RM series modular power supplies.

Circle 261

See ad page 68

Dynatech Tactical Communications

Booth 216

Existing products

Two-way radio accessories; wireless video systems.

New products

T-70-S; Dynapix HN-2000 wireless video system.

Circle 262

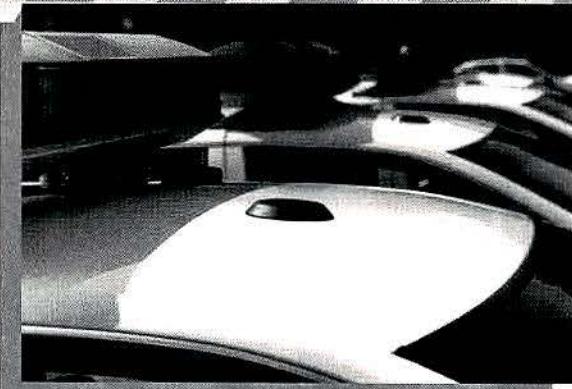
E.F. Johnson

Booth 1101

Existing products

Viking CX full-duplex LTR hand-held;

## LoPro® Mobile Antenna



**3dB gain ... only 5/8" high**

- Eliminate damage from car washes, bridges, garage doors and tree branches.
- UHF, Cellular and SMR/Trunking Frequencies
- Wireless data, radio telemetry, spread spectrum applications.
- Inconspicuous, less prone to theft and vandalism in public places.

**National Sales Office**

**(919) 403-8598**

Available through these distributors: AF CommSupply, Cartwright, Comm Associates, Comm Express, CMIC, Comark, C.O.P.S., Electro-Comm, Hutton, Pulstar, Talley, Tessco

LoPro® is a trademark of Northpoint Communications Products, Inc.

Circle (38) on Fast Fact Card



Visit us at  
Booth 1749  
IWCE '96

# Don't let the low price fool you.

It's a recurring theme. Whenever we explain how powerful and comprehensive ServicePlus is, people can't believe that they can get a total service information system for such a low price.

From a single point of entry (Logbook), you can access accurate customer data, equipment history, technicians, suppliers, service contracts, inventory and dispatch. This modular system uses look-up tables and pre-set defaults to make Work Order data entry and information retrieval fast and easy.

ServicePlus modules include:

- SP Manager
- Logbook (Work Orders/Invoicing)
- Inventory Control
- Service Contracts
- Dispatch
- Purchase Orders
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**ServicePlus**  
Service Information System

**Hottest Price/  
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# \$2780

Buys you SP Manager,  
Logbook, Inventory  
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Purchase Orders.



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Corporation

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Circle (39) on Fast Fact Card



**BIRD**  
**TECHNOLOGIES GROUP**

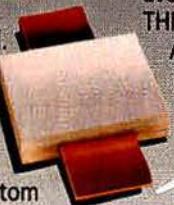
## Join The Celebration!

The formation of the Bird Technologies Group in 1995 went almost unnoticed, but it's starting to reverberate throughout the RF world. Comprised of Bird Component Products, Bird Electronic Corporation and TX RX Systems, this RF powerhouse has already launched a major technological breakthrough into the components market. And you can expect even more advances in the months and years ahead.

**Bird Component Products** was formed to design and manufacture high power attenuators, resistors, terminations and custom devices. Their new T<sup>2</sup> Technology

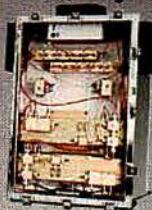
delivers significant improvements with outstanding advantages to anyone manufacturing RF and microwave equipment.

For over a half-century, **Bird Electronic Corporation** has produced power measurement instrumentation of uncompromising performance. Every Bird instrument, from rugged THRULINE® Wattmeters to the latest AT-800 Antenna Tester, will always deliver measurements you can trust.



**TECHNOLOGIES GROUP**

**TX RX Systems** brings two decades of excellence in the wireless infrastructure equipment market to our union. You can count on reliable, long-term performance from TX RX's complete line of multicouplers, repeater amplifier systems, duplexers and cavity filters.



Whether you need to create, manage or measure RF energy, there's a Bird Technologies Group company that can help put a bang in your business. To hear more about what we can do for you, call 216-248-1200.

U.S. Headquarters: Tel: 216-248-1200 Fax: 216-248-5426

Circle (40) on Fast Fact Card

## Expo

Viking mobile and hand-held LTR trunked radios; Viking repeaters and other LTR infrastructure equipment; multinet wide-area trunking.

*New products*

UHF model Avenger SE hand-held; Summit status messaging unit; DL-3412/22 synthesized data telemetry transceivers.

**Circle 263**

**Eagle Telecom International** **Booth 437**

*Existing products*

Paging base stations; Extend-A-Page repeaters; uBeep in-house paging terminal; transmitter controllers; MAC300 security system and pagers.

*New products*

Numeric UB2000 and tone-only pagers; Mini Terminal in-house paging; alphanumeric pagers; numeric + pagers.

**Circle 264**

[See ad page 56](#)

**EDX Engineering** **Booth 826**

*Existing products*

Signal master software package that predicts signal propagation for a wide variety of wireless communications systems; MCS PC program offers communication channel modeling using ray-tracing propagation techniques; terrain elevation databases covering the United States, Mexico and Great Britain.

*New products*

EDX SignalPro for Windows 95/NT, a comprehensive PCS/cellular system planning tool including coverage and interference analysis using the most advanced propagation models.

**Circle 265**

[See classified ads](#)

**El Paso Communications** **Booth 1955 (EPCOM)**

*Existing products*

Two-way radio communication equipment and accessories; engineering support, installation and guarantee.

*New products*

SYS1533, SYS4533 duplexers "Syscom"; T835, T855, T885 800MHz repeaters "Tait"; T Link 2300 "Syscom"; PM-400 telephone interconnector "Syscom."

**Circle 266**

[See ad page 100](#)

**Electro-Comm Distributing** **Booth 129**

*Existing products*

Distributor of a full line of two-way radio accessories.

*New products*

Full product line in cellular accessories; Nokia, Motorola and Audiovox cellular phones.

**Circle 267**

**EMR** **Booth 1616**

*Existing products*

All of the following components and systems

are available for use from 66MHz to 2.0GHz: Filter-ferrite and hybrid-ferrite combiners; I.M. control panels, isolators, harmonic filters and z-matchers; receiver multicouplers, towertop multicouplers, preselectors, preamps, power dividers and dualband couplers; bi-directional and unidirectional systems line taps and antennas; mobile, base station and small format base station antenna duplexers; BP cavities to 1.5kW and PN cavities to 400W.

*New products*

Models 7430(150), 7530(450) and 7630(900) low-power 20W single stage isolators; 25141 low-power 20W, four-channel UHF hybrid combiner; 64536/ENC 100W VHF (148-190) six-pole small format base station duplexer for 1.5MHz splits; 64A10/SBC 1kW to 1.5kW VHF bandpass cavity resonator.

**Circle 268**

[See ad on page 96](#)

**Engineered Endeavors** **Booth 1570**

*Existing products*

Taped tubular steel monopole structures; rotatable platforms; installation services.

**Circle 269**

**Enviro-Buildings** **Booth 461**

*Existing products*

Economical durable, lightweight modular building to accommodate shipping and easy installation with the patented cam-lock

# Wide, Clear Channels.

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SL-70W Handheld / SM-2000 Mobile

Circle (41) on Fast Fact Card



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- Charging of Nickel Cadmium, Nickel Metal Hydride, Lead Acid and Lithium chemistries.
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- Available with RS-232 serial port. The Optimizer 2000 can be operated from a computer to collect data and send commands.
- Available in 3 and 6 station units.
- Easy to read display: 3-unit 1.5" x 5.8", 6-unit 1.5" x 11.6".

Call, fax or write for more information.



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Win an Optimizer! Visit us at Booth #620 at IWCE.

Circle (42) on Fast Fact Card

## Expo

design—an alternative to conventional shelters.  
**Circle 270**

**Ericsson** **Booth 301**

*Existing products*

Enhanced Digital Access Communications System (EDACS) and products, including M-RK, Prism HP, Monogram portable radios and Orion mobiles.

*New products*

IPE Infinity portable; LPE-200 portable ra-

dio; Prism HM mobile radio; KPC portable; conventional desktop repeater; NPC-200 portable; Monogram EDACS mobile; NPC-50 portable.  
**Circle 271**

**ESI Cases and Accessories** **Booth 1953**

*Existing products*

Bravo; Bravo Plus; Lifestyle Plus; Memo Express; NEC; Panasonic; BPR; Advisor; clips; doors; buttons; chains; bungees.

*New products*

Ultra Express housings; Uniden XLT housings.  
**Circle 272**

**ETrunk Systems**

**Booth 327**

*Existing products*

ETR 500 repeater/base station; aftermarket trunking boards.

*New products*

ETR 5000 repeater/full duplex mobile trunking for Radiusport radios; ETrunk "Select" all digital trunking boards.

**Circle 273**

*See classified ads*

**Eventide**

**Booth 1557**

*Existing products*

VR 240 series DDS-2 DAT digital audio loggers; VR 204 series DDS-2 DAT digital audio loggers; VR 240 series 8mm hi-density digital audio loggers; ECW 40 series GPS satellite master time systems.

*New products*

VR 240 8mm hi-density digital audio recorder; ECW40 GPS satellite chronometer master time sync unit.

**Circle 274**

**Fanon Courier**

**Booth 1442**

*Existing products*

Courier Procom M54 and MU54 5W, four-channel crystal controlled VHF & UHF portable transceivers; Procom U22 2W, two-channel crystal controller UHF portable transceiver; Procom M510 and MU510 5W, 10-channel synthesized programmable portable VHF and UHF portable transceivers.

Fanon Megaphones; intercoms; P.A. amplifiers; paging/talkback speakers; paging systems.

*New products*

Courier Procom M520 5W, 20-channel synthesized programmable portable VHF transceivers; Procom MU520 5W, 20-channel synthesized programmable portable UHF transceivers.

**Circle 275**

*See classified ads*

**Fibrebond**

**Booth 1256**

*Existing products*

FibreLite panelized equipment shelter weighing 60% less than the conventional GFRC building, but retaining tough qualities like bullet resistance and portable durability.

*New products*

WinX31 cable wave radio systems.

**Circle 276**

**Fibrebond Resources**

**Booth 1256**

*Existing products*

Galvanized steel self-supporting and guyed lattice towers; turnkey site development services.

**Circle 277**

**Fibrebond West**

**Booth 1256**

*Existing products*

FibreLite panelized equipment shelter featuring an exposed aggregate or custom exterior that weighs 60% less than the conventional GFRC building.



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**Primus Electronics is  
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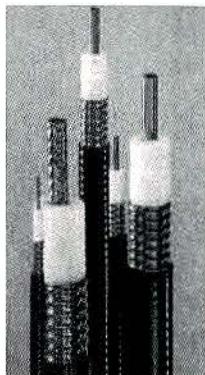


Andrew offers everything you need to build the highest quality transmission line system. In addition to coaxial cable, Andrew also offers a complete line of connectors, cable assemblies and accessories. Each is designed and tested to reduce intermodulation (IM) and optimize the mechanical and electrical performance of your entire transmission line system.

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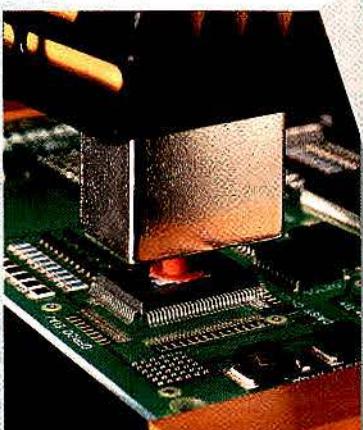
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FAX 800-767-7605**

Circle (43) on Fast Fact Card

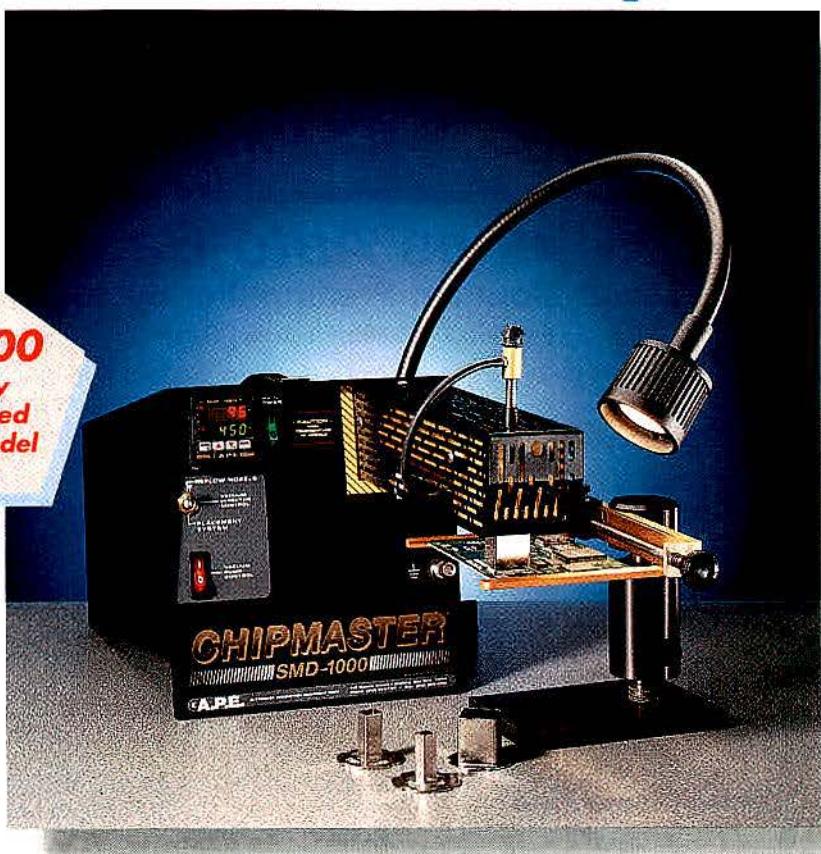
# PAGER/2-WAY/CELLULAR

## Rework and Repair

Let us show you how easy – and inexpensive – SMD removal and replacement can be! You won't believe that you can get so much capability – in such a reliable, quality built system – for so low a price!

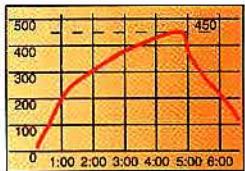


**\$3,800**  
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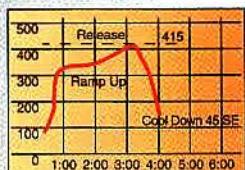


Patent Pending

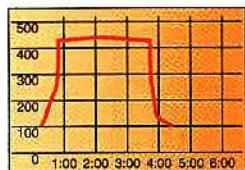
Some of the many rework profiles you can create and store using the Chipmaster's patented Microprocessor Controller.



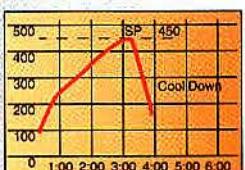
P.A. Module



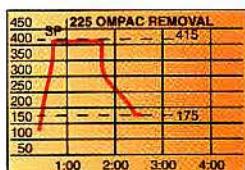
Cellular RF Shield



OMPAC, C5



Spectra PLCC



Bravo Express QFP



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## Expo

New products \_\_\_\_\_  
WinX31 cable wave radio system.  
**Circle 278**

**Filttronetics** Booth 855  
Existing products \_\_\_\_\_

LC and crystal filters; lowpass, highpass, bandpass and band reject filters, as well as phase match, linear phase and anti-alias type filters; frequency range in fundamental mode crystal filters is from 5kHz to 200MHz (500MHz 3rd overtone) and with LC filters as

high as 1GHz.

New products \_\_\_\_\_  
High frequency front-end crystal filters. A representative unit model FN-2102 has a center frequency of 159.030MHz, a 3dB bandwidth of 6kHz and a 55dB bandwidth of  $F_0 \pm 15\text{kHz}$ .  
**Circle 279**

**Flash Technology of America** Booth 1848  
Existing products \_\_\_\_\_  
Obstruction lighting products and systems

that are ETL certified: FAA-, DGAC-, ICAO- and Transport Canada-approved.

New products \_\_\_\_\_  
ElectroFlash FTB 312 medium-intensity dual (L-864/L-865) flashing obstruction beacon.  
**Circle 280**

**Frequency Management** Booth 930

Existing products \_\_\_\_\_  
Crystals for pagers, land mobile, microprocessor, commercial and OEM specifications; channel elements: complete element supplied or crystals made and installed in customers' elements; oscillators: various types, full and half-size, TTL, HCMOS, VCXO.  
**Circle 281**

**Fryer's Site Guide** Booth 347

Existing products \_\_\_\_\_  
All 1996 regional editions; on-line services; site search services.

New products \_\_\_\_\_  
CD ROM/electric book.  
**Circle 282**

**Fujitsu Microelectronics** Booth 1241

Existing products \_\_\_\_\_  
Prescalers; phase locked loops, saw filters; semi-custom RF LSI.

New products \_\_\_\_\_  
PCS saw filters; antenna duplexer; MBISEXX series PLL; MBISFXX series PLL; MBISSXX series PLL.  
**Circle 283**

**Gabriel Electronics** Booth 1440

Existing products \_\_\_\_\_  
Cellular and PCS base station panel antennas; microwave point-to-point antennas; transmission line systems; pressurization equipment.

New products \_\_\_\_\_  
Cellular and PCS base station panel antennas.  
**Circle 284**

**GEC Plessey** Booth 758

Existing products \_\_\_\_\_  
SP8900 series high-speed prescaler; SP885X series single chip synthesizers; SP8400 series low phase noise prescaler; SL3522 and SL2524 log/limiting amplifiers.

New products \_\_\_\_\_  
KESRX01 290 470MHz ASK Super-heterodyne radio receiver; KESTX01 400MHz-460MHz ASK radio transmitter; KESTX02 290MHz-360MHz ASK radio transmitter.  
**Circle 285**

**General Communications** Booth 910

Existing products \_\_\_\_\_  
Ericsson mobile radios and accessories.  
**Circle 286**

See classified ads

**Glenayre Electronics** Booth 1627

Existing products \_\_\_\_\_  
MVP; GL3000; GL6880; LNYX.  
New products \_\_\_\_\_  
GL6880 wireless line extenders.  
**Circle 287**

See ad page 55

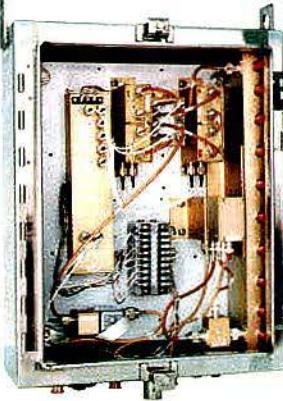
**Global Electronics International** Booth 1471

Existing products \_\_\_\_\_

## 422-Series Auto-Backup™ Tower-Mounted Preamplifier Systems

For the 806-960 MHz Frequency Range

U.S. PAT. #5,418,490



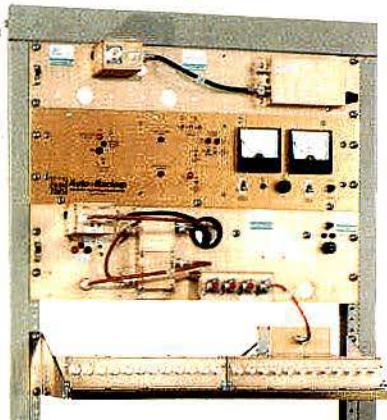
Model 422-86A-07-18-117  
Auto-Backup Tower-Mounted  
Preamplifier System

- *Auto-Backup system (US and other patents pending) monitors primary preamplifier and switches to backup preamplifier in case of primary failure.*
- *Secondary preamplifier is normally off-line and isolated from events that would destroy both amplifiers in competitive parallel-connected, "redundant" systems.*
- *High-selectivity, six- to ten-section combine preselectors for trunking, AMPS and GSM bands in 5, 10, 12.5, 15, 18 and 25 MHz bandwidths.*
- *Multiple power supplies with automatic battery backup for maximum system reliability.*

- *Ground-level control panel provides positive diagnostic and power backup capabilities via a separate DC cable.*
- *High-performance bipolar preamplifiers feature low noise figure and high output intercept point.*
- *High-performance receiver multicoupler output amplifiers have a third-order output intercept point of +43 dBm to assure a large dynamic range.*

### Auto-Backup...

The no-compromise receiving system for today's world.



Model 42-86A-42-24-117  
24-Channel Receiver Multicoupler with  
422-Series Auto-Backup Control  
Panel and RF Test Panel

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48 Mobile Radio Technology April 1996

Circle (45) on Fast Fact Card

# A Unique Approach to Battery Analyzers and Chargers

Communication • Cellular • Biomedical • Photography  
Charge • Analyze • Condition • NICAD • NiMH • Gel Cells



W & W Associates is proud to introduce its new line of affordable Battery Analyzers and Chargers. Our new line of MasterChargers® can charge NICAD as well as NiMH battery packs. These unique chargers are analyzer ready and employ state of the art microprocessors, enabling them to detect when a battery is fully charged utilizing a negative delta(V) and delta(T)/delta(t) detection techniques to establish when a battery is fully charged.

The Analyzer "I"® complements our line of battery chargers, when used in conjunction with the MasterCharger® Series. It enables you to: **Analyze - Condition - Charge - Discharge - and gives a readout in milliamperes.** The Analyzer "I" is the most cost effective analyzer in the market.

The Analyzer "III"® and the Analyzer "VI"® are three and six station analyzers, in which each station is independent of the others. These multi-station analyzers offer a choice of Charge/Discharge rates, in addition to having a provision for an external programmable load.

Please Call For Additional Information and Pricing

## W & W ASSOCIATES

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ALL SPECIFICATIONS & PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE

Circle (46) on Fast Fact Card

## Expo

Pager crystals.  
**Circle 288**

**GRE America** **Booth 744**  
Existing products \_\_\_\_\_  
GINA spread-spectrum radio modems.  
New products \_\_\_\_\_  
GINA model 8000NVK, 64kbps spread-spectrum radio modem.  
**Circle 289** **See ad page 115**

**Grundig Electronics** **Booth 217**  
Existing products \_\_\_\_\_  
GPS/AVL systems and software.  
**Circle 290**

**Hark Systems** **Booth 1735**  
Existing products \_\_\_\_\_  
MegaSwitch for SMR networking, one-number follow-me, voice mail, least cost routing. Terminates, TI; two-way DID and analog lines; SI-550EX with Author software allowing SMR enhancements for smaller systems providing DID, call forwarding, no answer transfer and automatic follow-me; CD100 rotary to DTMF converter; TNPP network controller.  
New products \_\_\_\_\_  
TSM 2000 tower site monitoring equipment with remote card access option—reports various alarm conditions, remote access for view-

ing events and keeps a detailed log of all events.  
**Circle 291** **See ad page 35**

**Hazeltine** **Booth 237**  
Existing products \_\_\_\_\_  
Phazar intelligent antenna systems; Phazar planar antennas; Chameleon antennas.  
New products \_\_\_\_\_  
Expanded line of Phazar planar antennas for ESMR and cellular, including 820-090-11-9, 806-050-14-0, 806-050-14-4, 806-105-11-0 and 806-080-11-0.  
**Circle 292**

**Hirschmann of America** **Booth 552**  
Existing products \_\_\_\_\_  
Mobile antennas — 30MHz–960MHz, 1.8GHz.  
New products \_\_\_\_\_  
MCA 1800 1.8GHz glass-mount mobile antenna; E5910 1.8GHz base antenna; MCA 1801 1.8GHz rooftop mobile antenna.  
**Circle 293** **See ad page 94**

**Hughes & Phillips** **Booth 249**  
Existing products \_\_\_\_\_  
Aircraft warning obstruction lights that are sold worldwide and are ETL certified and approved by the FAA, Transport Canada and ICAO. Product classifications are high-intensity strobe lights, medium-intensity

strobe lights, incandescent lighted red beacons, neon steady-burning warning lights and controllers for all systems.

**New products** \_\_\_\_\_  
24V D. C. FG3000 dual strobe beacon that provides red light for nighttime and white light for daytime.  
**Circle 294**

**Hustler** **Booth 1835**  
Existing products \_\_\_\_\_  
Spirit series omnidirectionals for PCS; G7-150 series for VHF; G6-450 series for UHF; Spirit series omnidirectionals for VHF and UHF.  
New products \_\_\_\_\_  
Microstrip panels for PCS—HR12-18189, single polarization, 12dBd; HRD12-18989 dual polarization, 12dBd.  
**Circle 295** **See ad page 53**

**Hutton Communications** **Booth 1211**  
Existing products \_\_\_\_\_  
Distributors of wireless communications equipment and components from more than 80 manufacturers, including antennas, batteries, cables, power supplies, test equipment and cellular accessories.  
New products \_\_\_\_\_  
1996 product selection guide; Hutton cellular products.  
**Circle 296** **See ad page 83**

# Geographic Signal Coverage At Your Fingertips.

*Introducing The STI-9100 Laptop Signal Measurement & Analysis System.*

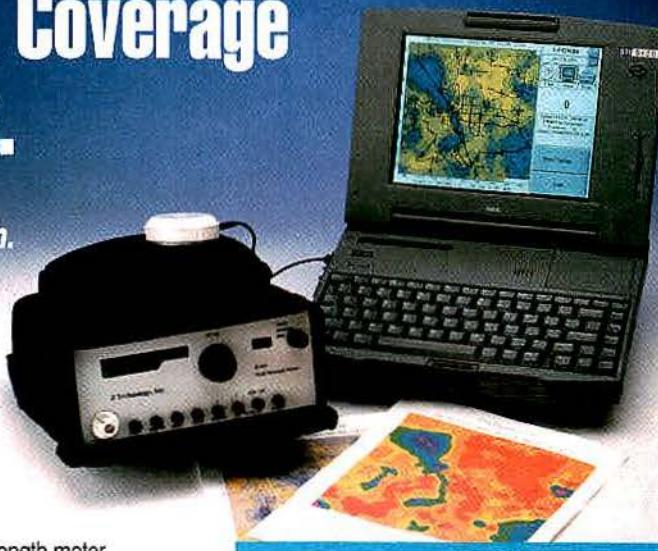
Our STI-9000 was the first mobile signal measurement & analysis system that allowed engineers to analyze RF signal coverage completely and see real time results.

Introducing the STI-9100 laptop. Smaller, lighter, faster, with an easy to use color graphic interface. The STI-9100 laptop is a turnkey system that easily installs in any drive test vehicle. The system is Windows®-based, includes a multi-channel GPS, and works with the field strength meter shown or your preferred communication receiver.

If you have a need for signal coverage measurement solutions in PCS, cellular, mobile radio, broadcast or paging, call for detailed product information, pricing and receiver options.

*"Setting the standard for communication system coverage analysis."*

Windows® is a trademark of Microsoft® Corporation.

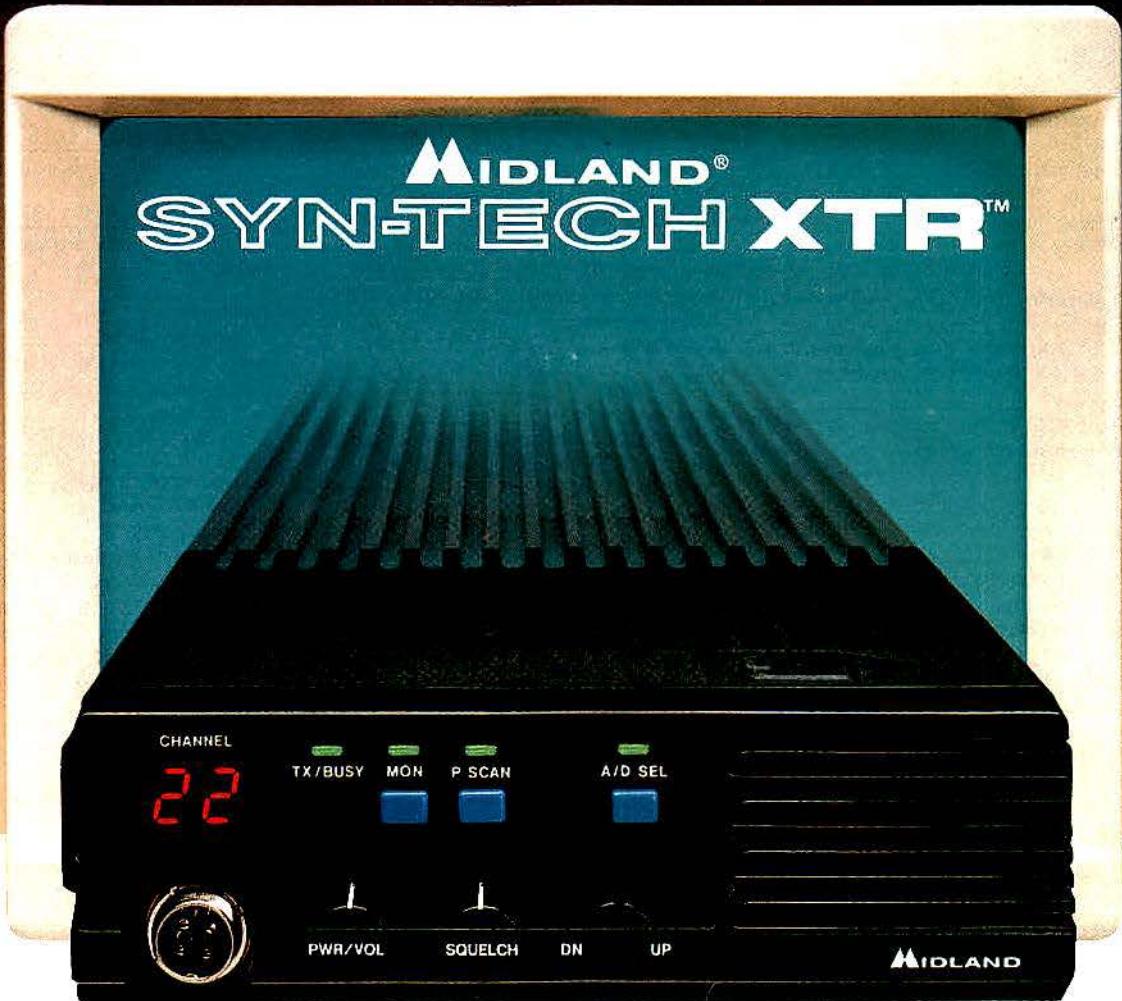


**STI** Survey Technologies Incorporated

*"Geographic Signal Coverage At Your Fingertips."*

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**503/848-8500**  
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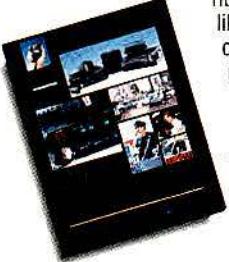
## No other mobile radio can do so many jobs, so well and so cost effectively!

### Performance

All the essentials you need to get the most from your system. Excellent Tx/Rx specs in lowband, VHF, UHF and 800 MHz models. Up to 99 channels and 110 Watts of transmit power. 10 Watts of external audio output. TOT. BCLO. CTCSS/DCS. 4 levels of 40-channels/second fast-scan capability, including priority scan.

### Versatility

These durable radios give you exceptional operational flexibility with a broad range of options, accessories and programming choices. Repeater talk-around for direct mobile-to-mobile communications. Optional modem for data communications. High-security scrambling. Features like: One of the smallest control heads available (trunk-mount version). A "mobile answering



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XTRordinary Syn-Tech XTR radios  
can improve your operations,  
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machine" with voice storage/message relay option. Various signalling formats including selective call and DTMF/ANI. Multi-Mode™ version is programmable for either 12.5 kHz or 25 kHz spacing by channel. Conventional and software trunking capabilities.

### Reliability

Projected failure-free service life is an average of over 20 years of regular 40-hour work weeks per unit.

### Value

Syn-Tech XTR radios deliver that rare combination of essential performance features, versatility, quality and reliability at reasonable cost. Backed by Midland's nationwide Sales & Service network, and responsive factory technical support when you need it.

### User Friendly Operation

Syn-Tech XTR radios are easy to use. Over 20 logical control panel options to exactly match your system requirements and the radio options you choose. Even dual controls.

### Durability

All models have rugged die-cast chassis and meet U.S. military specs for shock & vibration (MIL 810C/D). MIL SPEC protection against salt-fog, rain and dust also available.



**MIDLAND**  
LAND MOBILE RADIO **LMR**

## Expo

### Hy-Q International

#### Existing products

Communication crystals; pager crystals; crystals for all wireless applications; crystal oscillators.

Circle 297

Booth 730

See classified ads

### ICOM America

#### Existing products

F10, F20, F30 F40, F40LT hand-held transceivers; R1, R100, R7100 receivers.

#### New products

F1020, F2020 mobile transceivers; M710 single sideband transceiver.

Circle 298

Booth 1119

See ad page 57

### ICT

Booth 1951

#### Existing products

Switching power supplies; dc-dc converters; noise filters; high-current power supplies; base station covers.

#### New products

ICT12012-11AS 11A power supply with narrow footprint; ICT4812-10AS/20AS wide range input converters; ICT24012-40AS/60AS/80AS high-current power supplies; ICT12012-4AS 4A power supply with optional cigarette lighter plug-in; base station series—cover to use with Kenwood/Motorola radios.

Circle 299

### IDA

#### Existing products

V-series mics; 40-70 repeater interconnect; RLC-LTI trunking controllers; Net-Link; Easy-Link Plus; PC-Select Call; Tone & dc remote controllers; 20-88 mini console.

#### New products

Super 99 tone remote; SEA-CAD I; 6.0 ESAS billing software.

Circle 300

Booth 807

### Inmetco

#### Existing products

The recycling of spent NiCd and NiMH batteries.

#### New products

Cadmium recovery and recycling facility.

Circle 303

Booth 1660

### IFR Systems

Booth 1026

#### Existing products

COM-120B communications service monitor; Micro-cell-100 cellular test instrument; FM/AM-1600 CSA, TDMA cellular system analyzer; AN390A spectrum analyzer.

#### New products

Cellular digital packet data (CDPD) option for the MicroCell-100 will be demonstrated. The option allows the unit to simulate functions of mobile data base stations and mobile data intermediate systems.

Circle 301

See ad page 27, classifieds

### Indyme Electronics

Booth 1656

#### Existing products

FP 300 on-site telephone paging system.

#### New products

FP 200 on-site industrial/alarm paging system; FP 400 on-site integrated paging system.

Circle 302

### International Crystal Manufacturing

Booth 1027

#### Existing products

Quartz crystals; custom, microprocessor and surface mount crystal filters; discrete and monolithic crystal oscillators; 8- and 14-pin DIPs and custom design; communications equipment, pagers, portable and mobile radios; crystals and channel elements.

Circle 305

### Jan Crystals

Booth 956

#### Existing products

Crystals and clock oscillators.

Circle 306

### JBro Batteries

Booth 1930

#### Existing products

# Business is up! Ask Jim.

They laughed when he sat down at his bench to work on pagers.

*But when customers started lining up at his front door...*

Jim found the key to increasing his paging business was really simple: tap into the red hot, expanding pager service market! And why not. As the installed base of pagers grows, the demand for pager service grows with it.

Listen to Jim: *I had some bench equipment in my shop, but really didn't know a lot about pagers or pager repair. Motorola solved that problem. They have seven kits to choose from. Each kit comes with different test and bench equipment, tools and accessories depending on need and sophistication. I bought the Deluxe Enhanced Kit which included an RF Generator, FLEX™ encoder, Test Fixture and other test equipment and tools. Buying this kit saved me money from what I would have paid if I had bought the items individually. The kit I purchased also included enrollment for me in Motorola's Pager Repair Fundamentals course.*

*The course is an intensive 3-day immersion into the "how tos" of basic pager service. You'll get hands-on experience with pager programming, reprogramming... even recrystallization! They'll take you through basic paging systems, show you the proper way to assemble and disassemble pager housings and configure test and programming equipment.*

*So make pager repair part of your growing business. For more information, give Motorola a call at 1-800-543-9191.*



**MOTOROLA**

Americas Parts Division

1313 E. Algonquin Rd.  
Schaumburg, IL 60196

Web site: <http://www.mot.com/accesspoint>

Visit us at IWCE.

Circle (49) on Fast Fact Card

# Catch the winning spirit.

From the forge of world-wide competition comes the new Hustler *Spirit* series of vertical antennas.

Designed to win the race to provide the highest performance and durability possible, at a price that leaves others in the dust.

If you are driven to achieve a superior signal; if you need an antenna which is virtually impervious to wind and weather; if you want the best the world has to offer, catch our new *Spirit*-and win today.

*Model Shown: HS9-45070*

*Also Available: Models from 136 MHz. to 2 GHz., including Land Mobile, Cellular, Trunking, SMR, Paging and PCN. All models available in a variety of gain configurations.*



*Beyond your Expectations*

One Newtronics Place  
Mineral Wells, Texas 76067  
1-800-949-9490 • (817) 325-1386

YES, I'm interested in the new *Spirit*. Please send me your latest Professional Products catalog.

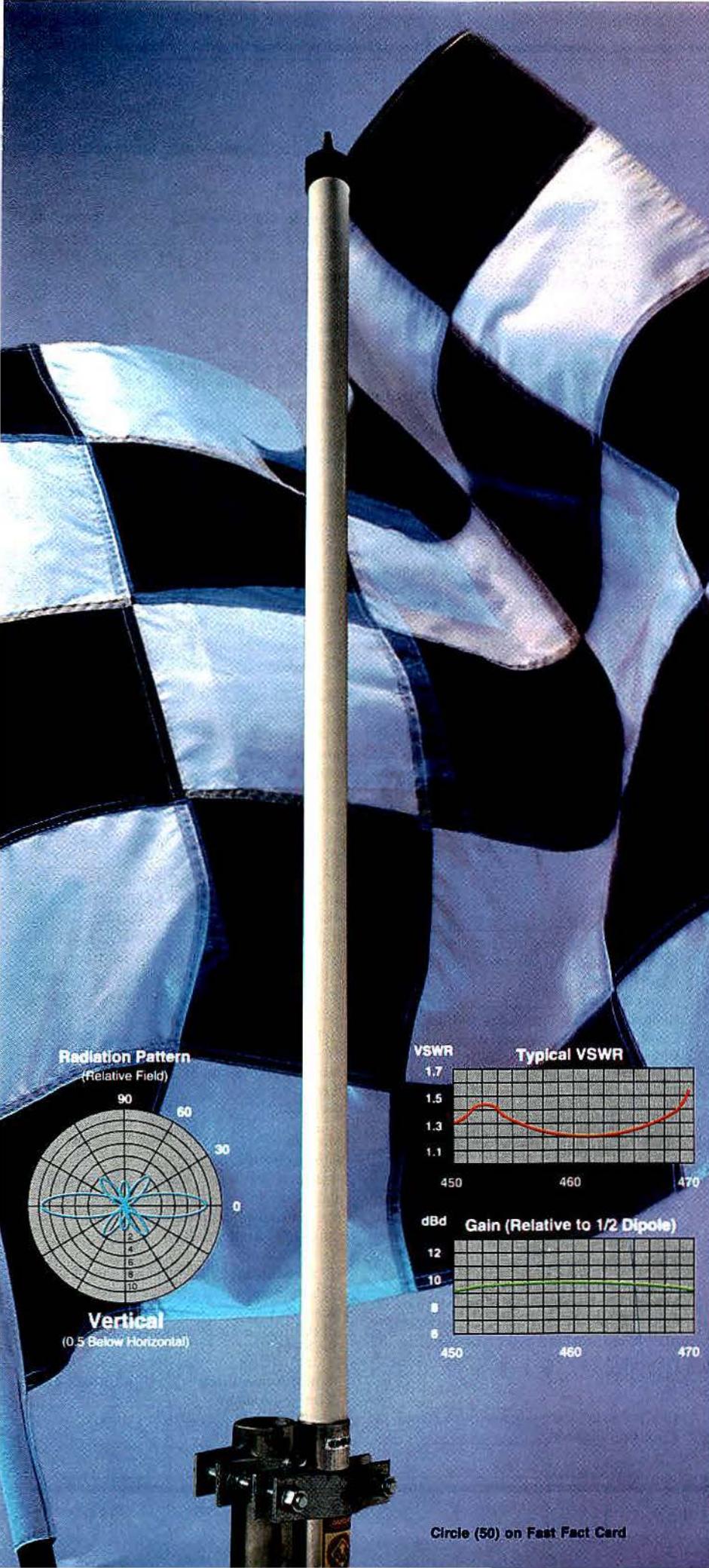
Name \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Circle (50) on Fast Fact Card



# Expo

Rechargeable batteries, including NiCd and sealed lead; custom assemblies; Telepower conditioner/analyzer advanced battery maintenance systems.

*New products* \_\_\_\_\_  
JB8148, JB7144, JB9018, JB1100.  
**Circle 307** *See ad page 38*

**JB Communications** **Booth 1918**  
*Existing products* \_\_\_\_\_  
CB and cellular antennas; mounts; connectors; cases; batteries; power cords; hands-free kits.  
*New products* \_\_\_\_\_  
Hands-free piece.  
**Circle 308**

**JFW Industries** **Booth 3969**  
*Existing products* \_\_\_\_\_  
Rotary attenuators: dc-2.5GHz; programmable attenuators: 800MHz-2.2GHz; power dividers/combiners: 800MHz-2.2GHz.  
*New products* \_\_\_\_\_  
Programmable simulation systems: 800MHz-2.2GHz; power divider assemblies: 800MHz-2.2GHz.  
**Circle 309** *See ad page 62*

**Kaval Electronics** **Booth 140**  
*Existing products* \_\_\_\_\_  
KVB-1, KUB-1, K8B-1 booster amplifiers; KV-OFR, KU-OFR, K8-OFR on-frequency repeaters; ACT-5-XX signal taps; CCT-5-XX signal taps; Trilogy Aircell cables.  
*New products* \_\_\_\_\_  
KU-OFR (470MHz-520MHz); ACT-75-XX and CCT75-XX signal taps for 3/4" Trilogy cable; 10W bidirectional amplifier.  
**Circle 310**

**KAViComm** **Booth 254**  
*Existing products* \_\_\_\_\_  
KV-16T trunked mobile; dispatch software; AVL software; accessories to mobiles; GPS receiver, mobile printer.  
*New products* \_\_\_\_\_  
KV-16RP repeater and base station; networker 1, one-channel transportable trunked network.  
**Circle 311**

**Kenwood Communications** **Booth 401**  
*Existing products* \_\_\_\_\_  
VHF/UHF portables and mobiles, base stations and repeaters; 30 series dash-mount, NPSPAC-compatible portable and repeater; trunking mobiles, portables and repeaters; custom and off-the-shelf radio systems; options and accessories for all products.  
*New products* \_\_\_\_\_

TK-260/360 VHF and UHF portable (pending FCC type acceptance); TK-353 trunked portable.  
**Circle 312** *See ad page 41*

**King Communications** **Booth 340**  
*New products* \_\_\_\_\_  
KDT 5000 mobile data system—high-speed, cost effective mobile data terminal and system software.  
**Circle 313** *See ad page 79*

**KNS Electronics** **Booth 1130**

*Existing products* \_\_\_\_\_  
Cushman K-30 frequency selective levelmeter; Cushman K-200 paging encoder.  
*New products* \_\_\_\_\_  
Cushman K-40 paging generator; Cushman K-90 communications service monitor; Cushman K-16 spectrum analyzer.  
**Circle 314** *See classified ads*

**Kyodo West** **Booth 217**

*Existing products* \_\_\_\_\_  
KG209 and KG309 portable radios; KG208 mobile radios; KG106 repeaters; KG110 base/repeater stations.  
**Circle 315** *See classified ads*

**Landmark Tower** **Booth 1252**

*Existing products* \_\_\_\_\_  
Landmark Type I & Type II towers; Skypod conventional self-support and guyed towers; Vexcel lift (tower elevator); Jewel tower; Star Pole (monopole); metal and fiberglass equipment shelters.  
**Circle 316** *See ad page 103, classifieds*

**Latcom** **Booth 2010**

*Existing products* \_\_\_\_\_  
Motorola Radius line; Uniden trunking line.  
**Circle 317**

**Lease Corporation of America** **Booth 259**

*Existing products* \_\_\_\_\_  
Lease/finance options for acquisition of wireless communication equipment.  
*New products* \_\_\_\_\_  
Floor planning; advance funding; commission-based rates; interest-free leasing.  
**Circle 318**

**Leathersmith** **Booth 1916**

*Existing products* \_\_\_\_\_  
More than 300 carrying case models—professional cases for all two-way radios and pagers.  
*New products* \_\_\_\_\_  
Economical dura-hide cases and sewn nylon cases; swivel options available.  
**Circle 319**

**David Levy** **Booth 1943**

*Existing products* \_\_\_\_\_  
Installation hardware; wire and wiring accessories; connectors; tools; test equipment; speakers; vehicle security.  
*New products* \_\_\_\_\_  
ProLink Hi-current installation accessories.  
**Circle 320**

**Lindgren RF Enclosures** **Booth 854**

*Existing products* \_\_\_\_\_  
Double electrically isolated RF shielded enclosures for the development, engineering, manufacturing and repair of wireless RF products.  
**Circle 321**

**LPKF CAD/CAM Systems** **Booth 761**

*Existing products* \_\_\_\_\_

93S circuit board plotter; auto-contact thru-hole plating system.  
**Circle 322**

**Lyncole XIT Grounding** **Booth 748**

*Existing products* \_\_\_\_\_  
Models 4500, 3710 and 725 AEMC test meters; XIT grounding rods.  
**Circle 323**

**Marketronics** **Booth 327**

*Existing products* \_\_\_\_\_  
Motorola two-way radios; SmarTrunk Systems SmarTrunk II; Tait MPTB27 four-channel system; Voyager rural telephone system; Andrew cable, connectors and accessories; Antenex mobile antennas.  
**Circle 324** *See ad page 30*

**Marconi Instruments** **Booth 635**

*Existing products* \_\_\_\_\_  
2945 radio and cellular test sets; 2965 radio and cellular test sets; 6200 microwave test set; 2050 series digital and vector modulation signal generators.  
*New products* \_\_\_\_\_  
2024 general purpose signal generator; 2390 series spectrum analyzers.  
**Circle 325**

**Mason Electric** **Booth 1461**

*Existing products* \_\_\_\_\_  
Portable radio adapters; headsets; microphones; cable and switch assemblies; helmets and helmet communication kits; active noise reduction systems.  
**Circle 326**

**Maxon America** **Booth 1801**

*Existing products* \_\_\_\_\_  
SP-2000 series synthesized portables; SM-4000 series synthesized mobiles; TP-4800/4801 trunking portables; TM-4800 series trunking mobiles; data/telemetry modules; SP-5050HD synthesized lowband portable; CP-0500 series crystal portable; compatible accessories and options; pagers and paging systems.  
*New products* \_\_\_\_\_  
SL-70W series scanning portables; SM-2000 series scanning mobiles; AN series alphanumeric pagers.  
**Circle 327** *See ad page 44*

**Maxrad** **Booth 1411**

*Existing products* \_\_\_\_\_  
Antennas for land mobile, cellular, marine and base station applications; mobile, marine and base station hardware and related accessory products.  
*New products* \_\_\_\_\_

GPS system antennas; MGPSA and MGPSD GPS antennas offer active or passive receive technology and are permanently encased in a rugged, molded polycarbonate shell.  
**Circle 328**

**Mentor Engineering** **Booth 1492**

*Existing products* \_\_\_\_\_  
Express mobile data system (MDT).  
**Circle 329**

# To SECURE YOUR FUTURE IN NPCS PAGING, DEPEND ON OUR PAST.

First with voice integrated into paging switch. First nationwide TNPP network. First with 2400 POCSAG. First ERMES system. First high speed FLEX™ system. First GPS synchronized system. First and only fully DSP based exciter.

If you are in the wireless messaging industry, you know how important it is to evolve with technology. That is why Glenayre invites you to put our history of success to work for your future. Throughout the years, we have consistently delivered the infrastructure developments needed to advance your business.

Industry achievements are to be expected from a proficient team that has remained focused on the advancements of one business for over twenty years. To secure your future in advanced messaging, rely on our history of successful products — paging switches, transmitters, transmitter control systems and receivers.

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**Glenayre®**  
WIRELESS MESSAGING GROUP

## Expo

**Meridian Communications** Booth 124

*Existing products*

Meridian provides and manages space at many well-located high-level and low-level community antenna site facilities in California.

*New products*

New sites include Eighth Street building in downtown Los Angeles; Frazier Mountain near Gorman; Oxnard Tower in Oxnard; Regency Plaza in Mission Valley/San Diego; Ribet building near Glendale.

Circle 330

See ad page 17, classifieds

**Merry Electronics** Booth 127

*Existing products*

CB microphones; land mobile microphones; vocal mics; dynamic transducer; accessories; external speakers; dynamic Mylar speakers; mic tester (noise, power, marine, base station, speaker, hands-free, DTMF, handset and bracket microphones); headset.

*New products*

DTR178 and CTR184 Merry brand transducers for cellular phones; EMC157 Merry hands-free mic for cellular phone or mobile phone.

Circle 331

**Microcomm** Booth 1553

*Existing products*

M340 Microlink voice and data multiplexers; M400 series rural telephone adapters; M681

network repeater controllers.

*New products*

M340 Microlink voice and data multiplexer; M400 four-channel rural phone system.

Circle 332

**Microwave Data Systems** Booth 2050

*Existing products*

MDS 450D/950D point-to-point; MDS 460D/960D; MDS MX-2000 high-speed time division multiplexer; MDS 9310 spread-spectrum; MDS 2100/4100 multiple address master station; MDS 2310A/4310 multiple address remote transceivers.

*New products*

MDS SST1/SSE1 license-free 2.4GHz spread-spectrum.

Circle 333

**Midian Electronics** Booth 200

*Existing products*

Tone signaling products; encoders; decoders; voice scramblers, rolling code and inversion.

*New Products*

RC10/RD10 remote control products.

Circle 334

**Midland International** Booth 1601

*Existing products*

70-000 series Syn-Tech XTR and Syn-Tech II mobile radios; 70-000 series Syn-Tech XTR desktop radios and accessories; 70-000 series

Midland portable radios and accessories; 71-000 series Base-Tech repeaters, base stations, options; 18-000 series base station and mobile antennas.

*New Products*

95-3115 Roamer One 220MHz mobiles; Midland XTR and Syn-Tech II multi-mode mobiles; 71-000 series Base-Tech III base/repeater stations.

Circle 335

See ad page 51

**Milcom International** Booth 827

*Existing products*

Linear amplifiers, 1MHz-1GHz; RF power base/repeater amplifiers; PT900 series paging transmitters; multichannel feed-forward amplifiers.

*New Products*

PT900 series paging amplifiers; MCA9000-250 high-power, multichannel, feed-forward amplifier for CDMA/TDMA/analog applications.

Circle 336

**John Mitchell Company** Booth 244

*Existing products*

Radiopac V software

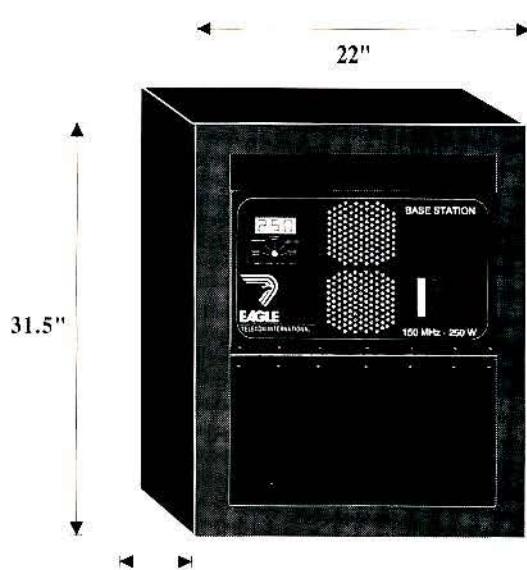
*New Products*

Radiopac V software with downloadable formats for ESAS, Smartlink and Syscon, and Managed Sites features

Circle 337

# STEALTH SERIES BASE STATIONS

THE TOTAL, COMPACT, RF PACKAGE FROM EAGLE TELECOM



Come See the Real Thing at  
IWCE Booth #437

- **VHF, UHF, & 900 MHz**
- **Power Levels up to 500 Watts**
- **100% Solid State Continuous Duty**
- **Fully Synthesized Exciter**
- **High Stability Simulcast Capability**
- **Supports Most Transmitter Control Formats**
- **Superior Thermal Design**
- **Front Panel Monitoring and Displays**
- **Lockable Slimline Cabinet**
- **Easily Removable Doors**
- **Fold Out Workshelves**
- **Rack Mount Modular Design**
- **Remote Diagnostic Capability**



**Eagle Telecom International**

910 Gemini  
Houston, TX 77058

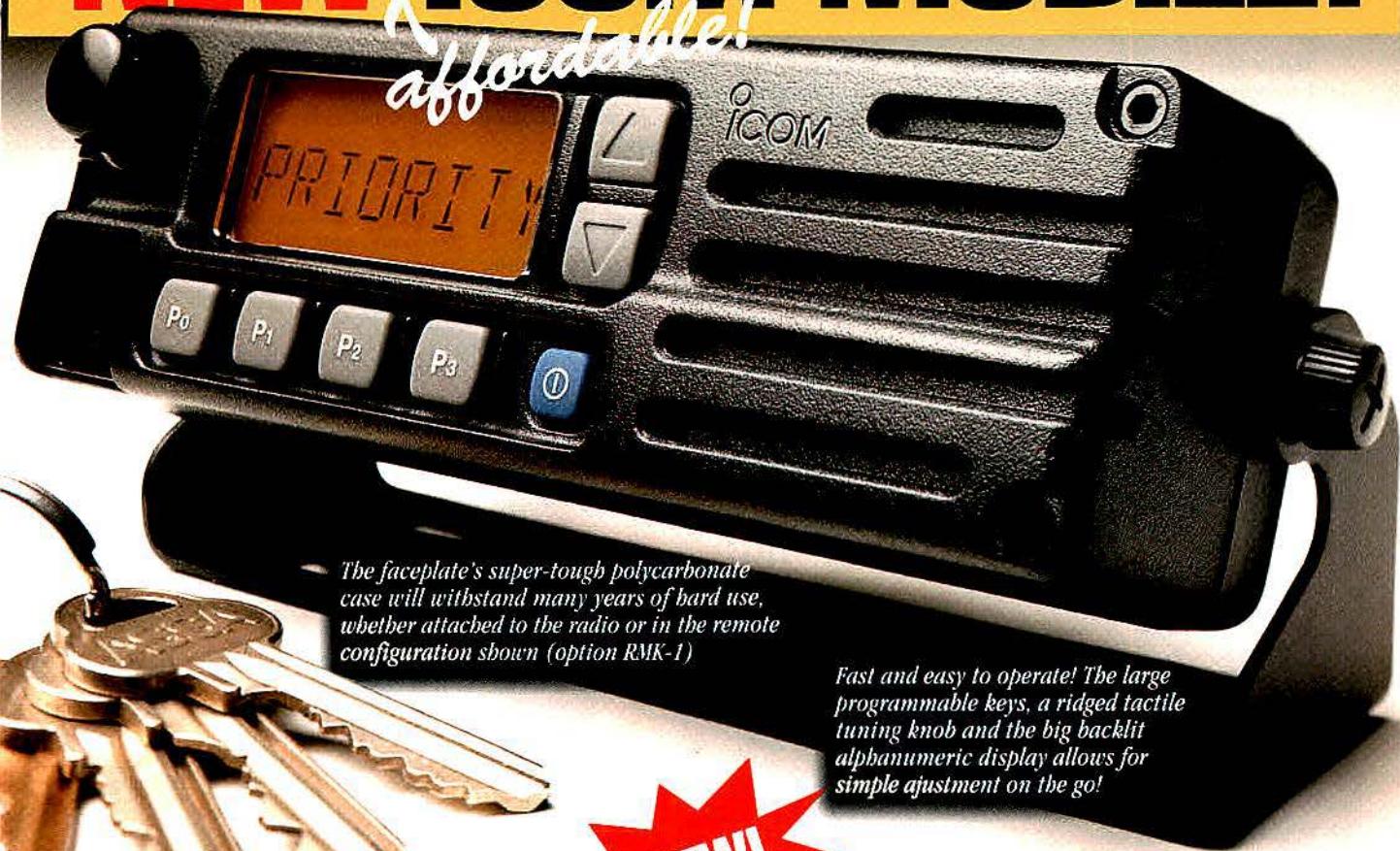
**1-800-628-3910**

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Fax: (713) 280-0381

Circle (52) on Fast Fact Card

# NEW ICOM MOBILE!

*affordable!*



The faceplate's super-tough polycarbonate case will withstand many years of hard use, whether attached to the radio or in the remote configuration shown (option RMK-1)

Fast and easy to operate! The large programmable keys, a ridged tactile tuning knob and the big backlit alphanumeric display allows for simple adjustment on the go!

#### Frequency Coverage:

IC-F1020:	136-155 MHz
	146-174 MHz
IC-F2020:	400-430 MHz
	450-470 MHz
	470-490 MHz
	490-512 MHz

#### Number of Channels:

32 (standard),  
160 (optional)

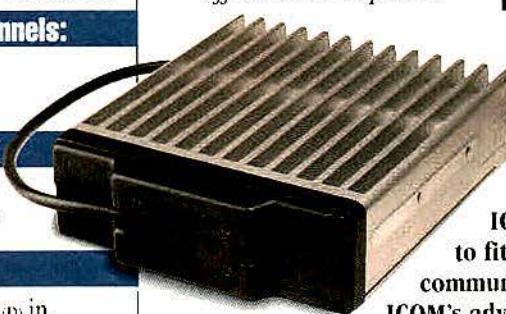
#### Output Power:

Tx: High 25 W  
Low 2.5 W

#### Dimensions:

5 7/8 (W) x 2 (H) x 7 1/8 (D) in,  
3 lbs, 5 oz.  
150 (W) x 50 (H) x 180 (D) mm,  
1.5 kg

A one piece, die cast aluminum radio body construction makes for extreme durability and efficient heat dispersion



Tailor the IC-F1020/IC-F2020 to fit your special

communication needs using

ICOM's advanced PC programming package! • Data capable • Auto DTMF ANI  
• CTCSS with all standard EIA tones (2-tone sequential is built-in. With the UT-96 option, program 2-tones by channel) • DTCS • Talk around • Priority channels  
• 5 scan channel groups (normal/priority) • Horn honk  
• Time-out-timer • and much, much more!

Call 206-450-6088 today for a FREE brochure or the location of your nearest ICOM dealer

All ICOM Land Mobile radio sales are backed by ICOM's talented service support group

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Circle (53) on Fast Fact Card

Ultra-Small,  
Ultra-Capable  
...and Priced  
Right!

**ICOM**  
LAND MOBILE

## Expo

### Mobile Mark

#### Existing products

Antennas for cellular, land mobile, trunking, PCS and HF applications to 2.6GHz; mobile, portable and base station antennas; glass-mount antennas; Mini-Mark car kit antenna; Clip-On and Mag-Mount portable antennas; RM series roof-mount antennas; marine antennas; fixed-site antennas.

#### New Products

External car antenna coupler connection for

### Booth 226

Motorola phones; PCS and ISM antennas; omnidirectional and directional site antennas; installed and portable car antennas; portable/OEM antennas for hand-held devices.

**Circle 338**

### Mobile Radio Technology

#### Existing products

Mobile Radio Technology is recognized as the leading source of technology-focused industry guidance. Readers include mobile radio

dealers and service shops, large-volume end-users at public safety, government, transportation, business and industrial agencies, as well as paging and SMR service providers, and manufacturers and their reps and distributors. The editorial addresses the latest in equipment and applications, business developments, legal and regulatory matters. Visit our booth to pick up a copy and sign up for your free subscription.

**Circle 339**

### Modular Communication Systems

### Booth 427

#### Existing products

Ultra-Com consoles for dispatch centers.

**Circle 340**

**See ad page 59**

## When 2-Way Radio Communication is critical . . . OTTO's Noise-Attenuating Headsets deliver



OTTO V4000 Headsets feature 24dB noise reduction rating (NRR), comfortable ear seals, flexible boom with noise-canceling electret microphone, in-line PTT and durable cable construction. Standard or behind-the-head style for use with head gear.

### OTTO 2-Way Audio Accessories:

- Headsets
- Earphone Kits
- Surveillance Kits
- Remote Speaker Mics



# OTTO®

OTTO Engineering, Inc. • 2 East Main Street • Carpentersville, IL 60110  
Phone: 847 428-7171 • FAX: 847 428-1956

Circle (54) on Fast Fact Card

### Natcom

### Booth 435

#### Existing products

Motorola pagers and in-house paging systems; refurbished pagers; top-quality pager repair.

**Circle 341**

**See ad page 77**

### NCG/Comet Antenna

### Booth 2020

#### Existing products

Comet single-band, dual-band and triple-band VHF/UHF/cellular antennas.

#### New Products

Comet FX-555NMO VHF/UHF/cellular mobile antenna.

**Circle 342**

### Neulink Division/RF Industries Booth 754

#### Existing products

Low-speed, crystal-controlled modems; high-speed synthesized transceiver modems; telemetry transceivers; wireless network controllers.

#### New Products

Miniature wireless network controllers; 900MHz spread-spectrum transceiver modems; synthesized 900MHz modems.

**Circle 343**

### Newmar

### Booth 149

#### Existing products

Communication power products; battery chargers; power supplies; dc converters; complete power rack systems, including distribution panels, disconnect and meter panels; mobile and rack-mount configurations.

#### New Products

Integrated power system for paging terminals, repeaters, microcell base station or GMDSS.

**Circle 344**

### Nida Communications

### Booth 144

#### Existing products

PTR-200 portable tactical repeater; shoulder pack radio series; tactical repeater duplexer; portable communication consoles.

#### New Products

RC-200 repeater controller.

**Circle 345**

### Noise Cancellation Technologies

### Booth 1944

#### Existing products

# MODUCOM Ultra-Com PRO

## The "No-Compromise" Dispatch Consoles meeting all your communications control needs

**Moducom's Ultra-Com PRO** represents a significant increase in dispatch console capabilities and flexibility. Whether stand-alone or as part of a multi-position console, the **Ultra-Com PRO** provides more features, more control and unparalleled flexibility.

The **Ultra-Com PRO**'s design is based on the concept of multiple workstations sharing common electronics. Control for each dispatcher position is provided with a 33 MHz. Intel 486-based operator interface. An optional Pentium PC is available.

The **Ultra-Com PRO** is the only dispatch console available today that permits the operator to program and modify the complete system without outside technical assistance. Using Moducom's exclusive "Screenmaker" and "Customizer" programs, the user can easily and quickly design operating screens for function, appearance, color, switch sizes and location, and develop other functions unique to each operation. In addition, Moducom provides software updates for the system at no cost.

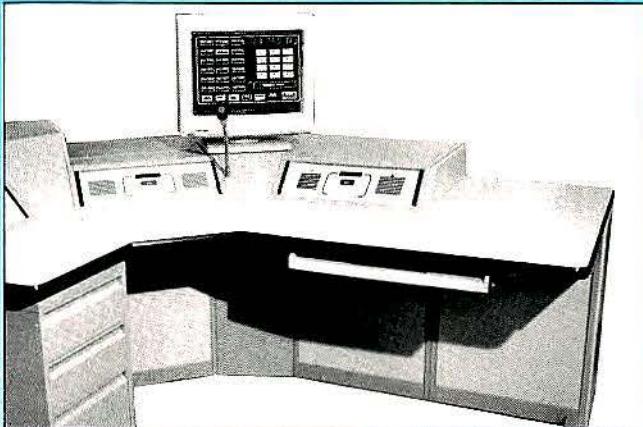
*Call, Fax or write for our  
complete literature package.*

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**MODULAR  
COMMUNICATION  
SYSTEMS, INC.**

---

13309 Saticoy St., No. Hollywood, CA 91605 (818) 764-1333 / FAX (818) 764-1992



The **Ultra-Com PRO** is available with standard color monitors, with mouse or track-ball, and with 14-inch, 17-inch or 20-inch touch-screen monitors.

*Moducom dispatch consoles and systems are designed for today's emergency communications requirements...and for the future.*



## Expo

ProActive headsets; adaptive speech filter; X-Static chip.  
**Circle 346**

**Northpoint Communication Products** Booth 1652

*Existing products* \_\_\_\_\_  
UHF, cellular and SMR/trunking series LoPro mobile antennas.  
**Circle 347**

*See ad page 42*

**Fred A. Nudd Corporation** Booth 2003  
*Existing products* \_\_\_\_\_  
Complete line of guyed towers, self-supporting towers, monopoles and antenna mounts.  
**Circle 348**

**Nutel Electronics** Booth 1919  
*Existing products* \_\_\_\_\_  
8000 series 790MHz-2,500MHz point-to-point microwave radio; 9000 series

1.700MHz-2,700MHz point-to-point microwave radio; 9500 series FDM voice multiplex.  
**Circle 349**

*See ad page 90*

**OptaPhone Systems** Booth 100

*Existing products* \_\_\_\_\_  
Optaphone Plus 2000 radio telephone links; Optaphone Star multi-access radio telephone systems.

*New Products* \_\_\_\_\_  
Optaphone First Access Network (FAN) wireless local loop system; Optaphone 2000 Plus-2 two-line radio telephone links.  
**Circle 350**

*See ad page 99*

**Orbacom Systems** Booth 1965

*Existing products* \_\_\_\_\_  
TDM-150 CRT communications console and control center; TDM-150 modular communications console and control center; desktop and rack-mount Calida and console.  
**Circle 351**

*See ad page 67*

**Otto Engineering** Booth 557

*New Products* \_\_\_\_\_  
V1 series surveillance accessories; ultra-lightweight headset; V4 series noise attenuating headsets.  
**Circle 352**

*See ad page 58*

**Pace** Booth 141

*Existing products* \_\_\_\_\_  
Soldering, assembly and repair systems; MBT 250A; ST 20A; ST 20A-TT; ST-SX; ST 40A; PRC 2000; Thermobond Cirkit; Multi Arm-Evac; Ventur-Evac.  
**Circle 353**

**Booth 141**

**Pacific Crest** Booth 1940

*Existing products* \_\_\_\_\_  
RFM96 radio modems; RFA96 power amps.  
*New Products* \_\_\_\_\_  
TM32 radio modem.  
**Circle 354**

**Booth 1940**

PacketCluster Systems, see Cerulean Technology

**PanaVise Products** Booth 446

*Existing products* \_\_\_\_\_  
Cellular phone mounts; portable phone holders; MDT mounts; radio mounts; electronic servicing tools; security camera mounts; speaker mounts.  
*New Products* \_\_\_\_\_  
Speaker mounts 100106B and 100106W.  
**Circle 355**

**Booth 446**

**Peiker Acoustic** Booth 1458

*Existing products* \_\_\_\_\_  
DTMF microphones; desktop mics; gooseneck mics; hand mics; mic-loudspeaker combinations; headsets; handsets.  
*New Products* \_\_\_\_\_

HA65 DTMF handset; PS30/12T DTMF desk mic.  
**Circle 356**

**Booth 1458**

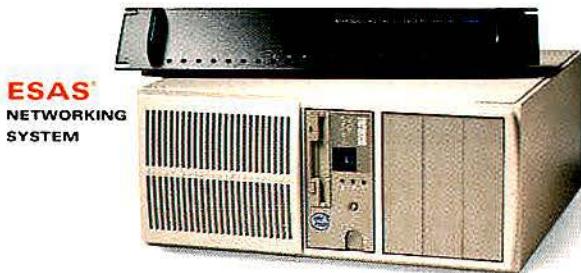
**Pipo Communications** Booth 1901

*Existing products* \_\_\_\_\_  
AE-1 4.0; AE-1 PC programmer; PK-1K ANI

## KNOW WHICH WAY TO TURN ON THE INFORMATION HIGHWAY?



### UNIDEN TWO-WAY.



Uniden offers a full line of reliable mobile and portable radios engineered to move you seamlessly over today's information highway.

From our durable, lightweight portables. To our powerful, feature-rich mobiles. All current trunking

products are integrated with the revolutionary ESAS® networking system from Uniden.

See your Uniden dealer today. And they'll turn you in the right direction.

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Quality Goes the Distance

For more information, please call us today at 817-858-3300.  
See us at IWCE/Spring, Booth 120!

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Circle (56) on Fast Fact Card

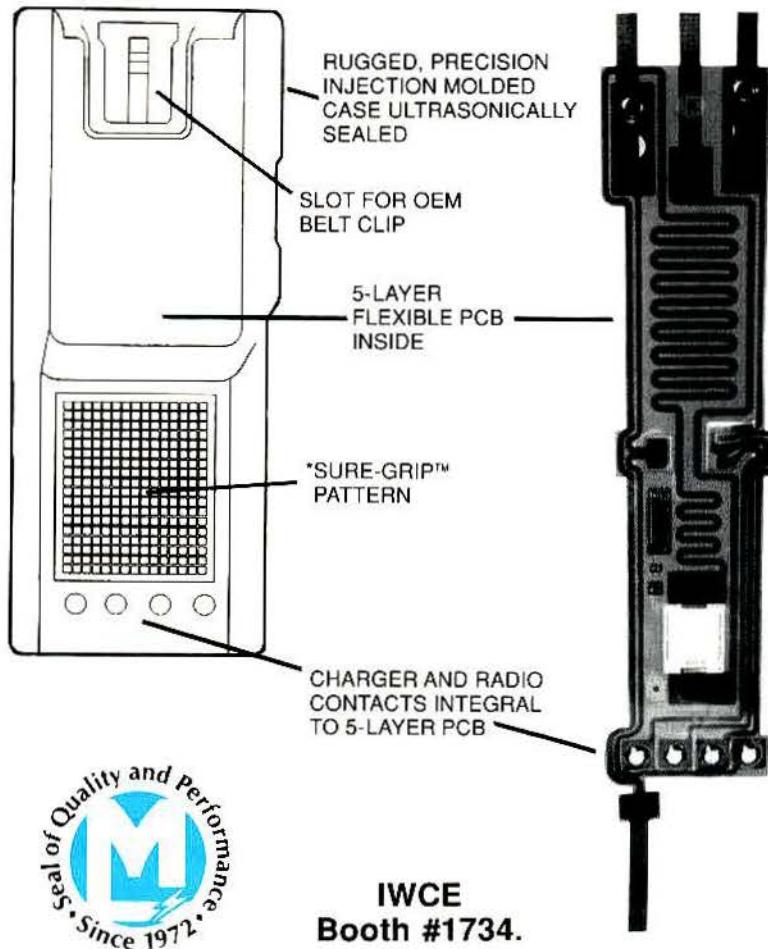
New



## Multplier Replacement Battery Pack for Motorola GP300 Radio Model M9628

# 2

Multi-layer, flexible PCBs and rugged, precision cases are features which make Multplier batteries the most reliable  
...less than 1/10th of 1% fail in warranty (1 year) in conditions from the arctic to the tropics!



IWCE  
Booth #1734.

### Value Added Features to M9628 NiCad battery pack.

- ◆ Five-layer flexible PCB has 2 conductive and 3 laminate layers. Electronic components assembled to PCB include a diode for cell protection, thermistor to protect against heating during the charge cycle and a loading resistor to control current flow.
- ◆ Modified clip holder on battery accepts O.E.M. clip and battery fits all existing holders and leather cases.
- ◆ Multplier \*SURE-GRIP™ checkerboard case surface provides an attractive look and better grip, and is available on select Motorola radio and cellular phone replacement batteries.

\*Certain batteries with SURE-GRIP™ surface design are patent pending.  
All are trademarked.

Select from over 1800 batteries and accessories for Cellular, GSM and Two-Way/PMR radios and phones.



1-800-642-2424 (Outside NY)  
1-914-241-9510 (In New York)  
FAX 1-914-241-1103

Circle (57) on Fast Fact Card



## Expo

3.2; PK-2K ANI 3.2; PD-822 decoder.  
**Circle 357** *See classified ads*

**PolyPhaser** **Booth 335**

*Existing products*

Coaxial protector series (RF/data/LAN/video) for GPS/cellular/paging; wire pairs protector series (data/LAN/telco/analog/digital); power lines (ac and dc/plug-in/hardwire); grounding equipment and systems.

**Circle 358** *See ad page 32F*

**Power Conversion Products** **Booth 1555**

*Existing products*

Ac-to-dc rectifiers; modular, hot plug-in dc power systems; de-to-de converters and outdoor enclosures with complete dc power systems.

*New Products*

TwinPack Plus dc power systems; SSD2 system status and control panel; mini-power node (outdoor enclosure with complete ac-to-dc power system).

**Circle 359**

**Primus Electronics** **Booth 356**

*Existing products*

Brands including Andrew, PolyPhaser, Astron, Times Microwave Systems, Antenna Specialists, Decibel Products and Maxrad.

**Circle 360** *See ad page 46*

**Professional Technology Systems** **Booth 217**

*Existing products*

System integration specialists.

*New Products*

Kyodo West land mobile communications products; Grundig Electronics GPS/AVL systems and software; Teletec amplifiers, mobiles and microwave systems; Berry Control SCADA systems and software.

**Circle 361**

**RadioMate** **Booth 427**

*Existing products*

Headsets and audio accessories for two-way radios: portables, mobiles, base stations and dispatch consoles.

*New Products*

RadioMate headset for portable digital IDEN radios.

**Circle 362**

**Rein Communications** **Booth 601**

*Existing products*

Crystal and synthesized mobile, portable and base radios and repeaters; base station components and subsystems; multiplexed antenna systems and IM-suppression products.

*New Products*

DRU UHF synthesized desktop repeater; DBU UHF synthesized desktop base station.

**Circle 363** *See ad page 11*

**RF Design** **Booth 819**

*Existing products*

*RF Design* is the only technical publication written exclusively for engineers working in those radio frequencies where the behavior of

circuits and systems requires specialized design techniques. It presents classical and leading-edge RF design methods using a practical, instructional approach.

**Circle 364**

**RF Imaging and Communications** **Booth 1459**

*Existing products*

Used radio service monitors and system analyzers—Motorola, IFR, Wavetek and Cushman.

**Circle 365**

*See classified ads*

**RF Industries** **Booth 727**

*Existing products*

RFA-4027 SMA technician's adapter kit; RFA-4017 coaxial cable testing kit; RFF-1442 right-angle PCB mount connector; RFX-3056 NEC crimp-on connector for the NEC P300.

**Circle 366**

RFA-4026 cellular technician's radio adapter kit; RFD series 7/16 DIN connectors; RFX series FCC Regulation 15 connectors; RFN-1001-S N male universal cable plug connector; PT-4000-200 RFI Unadapt inductive coupler.

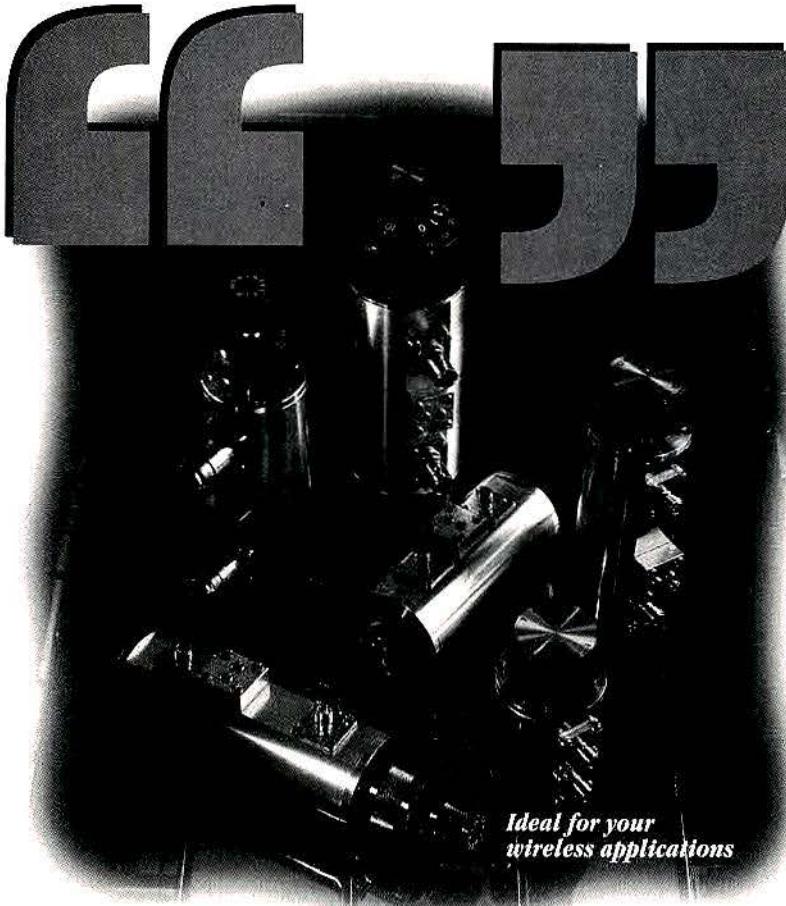
**Circle 366**

**RF Technology** **Booth 931**

*Existing products*

Eclipse series base stations, repeaters, links, modular receivers, transmitters and power amplifiers.

**Circle 367**



*Ideal for your wireless applications*

# JFW Rotary Attenuators just won't shut up!

*JFW Industries' products speak volumes without saying a word.*

The quality and precision of our standard and application specific rotary attenuators are loud and clear.

If your requirements demand DC-2.2 GHz with 80dB of attenuation, we can deliver. If your special applications include custom designs with state-of-the-art craftsmanship, we can deliver, on time and within your budget.

For nearly two decades we have been telling you that no one can match our performance. Now we let our rotary attenuators do the talking.

*For more information or for a free catalog, contact:*

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Indianapolis, Indiana 46237

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*JFW Industries . . .  
our quality speaks for itself!*

Circle (58) on Fast Fact Card



## Cell Reach™

### Designed for the Jungle Out There

It's a jungle out there. CommScope understands. That's why we've introduced Cell Reach — an installer-friendly, high-performance cable that minimizes EMI, enhances signal integrity and eliminates intermodulation concerns.

Cell Reach is designed with a patented, triple-bonded construction. The high-strength, closed micro-cell foam dielectric eliminates water migration, while providing superior electrical properties. And its smooth-wall copper shield provides the lowest VSWR.

We know it's tough to survive. But CommScope can help. Call us today at **888 CELL REACH** for more information about Cell Reach transmission systems.



## Cell Reach™

A true broadband, digital-ready cable specifically designed for wireless transmission systems.

CommScope  
**G** General Instrument

P O Box 1729 / 1375 Lenoir-Rhyne Blvd.  
Hickory, North Carolina 28603-1729  
Phone 800 982 1708 / 704 324 2200  
Fax 704 328 3400  
<http://www.commscope.com/>



## Expo

Eclipse 800 series receivers and transmitters.  
**Circle 367**

**Ritron** **Booth 617**

*Existing products* Patriot brand synthesized, programmable portables, mobiles, repeaters, low-band, VHF and UHF; Jobcom portable radios, crystal and synthesized; wireless telemetry systems and products; data transceivers and analog/digital I/O systems; Telenexus wireless telephone line extender system.

*New Products* Jobcom JMX portable radio; RRX-450 synthesized, programmable repeater; Telenexus telephone line extender system; DTX synthesized RF transceivers, data telemetry modules; Dataflow RTU RF telemetry system, analog or digital I/O RF system.

**Circle 368** [See ad pages 93, 97, 101](#)

**Rockwell** **Booth 104**

*Existing products* FleetMaster GPS-based fleet management system.

*New Products* FleetMaster with CDPD communications; FleetMaster with RAM Mobile Data communications; FleetMaster with mobile radio communications.

**Circle 369**

**Rohn** **Booth 919**

*Existing products*

Self-supporting towers; guyed towers; steel poles; concrete poles; antenna mounts; obstruction lighting; safety climbing devices; concrete shelters; fiberglass shelters; cabinets.

*New Products*

Non-combustible rooftop equipment shelter; "Knock-down" site-assembled equipment shelter; rooftop non-penetrating cabinet/antenna mounts.

**Circle 370**

**Ruf\*Nek Building Systems** **Booth 640**

*Existing products*

Concrete communication shelter.

**Circle 371**

**Samlex America** **Booth 443**

*Existing products*

RPS power supplies, 2A-50A; SCP voltage converters, 6A, 8A, 10A; SI dc-to-ac inverters, 100W-1,500W; PSE smart chargers, 8A, 12A, 15A.

*New Products*

SEC-1212 switchmode base station power supply; SDC-15 switchmode, 15A, 24Vdc-12Vdc converter; FCP-1000 lamp cellphone power supply/charger.

**Circle 372** [See ad page 92](#)

**Samsung Semiconductor**

*Existing products*

Digital attenuators; voltage-variable attenuators; general-purpose amplifiers; SPDT switch.

*New Products*

Cellular power module (AMPS); cellular power module (dualmode; CDMA), 1W, 7.2V; cellular power module (dualmode; CDMA), 1W, 4.7V; PFET (TDMA), 1W, 4.7V; PFET (CDMA), 1W, 4.7V; medium PFET, 0.1W, 4.7V.

**Circle 373**

**Scala Electronic**

*Existing products*

Americell panel antennas for cellular and trunking applications; Omni base station antennas for trunking, cellular, communications and PCS.

*New Products*

SMT-1000 mobile test set for analog and digital systems; high-power transmit omnidirectional antennas; panel antennas with new beamwidth and down-tilt configurations.

**Circle 374**

**Scientific Dimensions**

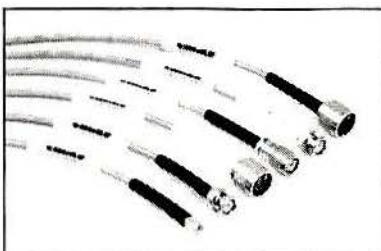
*Existing products*

SDI 1650 42 cavity slide mount; SDI 7200 console mount; SDI 5140 high-profile mount-

## COAXIAL CABLE ASSEMBLIES

### FEATURES:

- Rugged! survives 60 lb. pull
- Low loss
- Low Cost
- Each cable Swept to 3.0 GHz
- Custom labels available
- Large connector choice
- Excellent Return Loss



Frustrated with cable assemblies that break easily or don't work at low microwave, or intermittent? Now, EAGLE offers cable assemblies designed for demanding low microwave field use, such as cellular, PCS and wireless. Individual testing to 3.0 GHz assures consistency. They are also mechanically tested to insure the connectors won't fall, or be pulled, off. Double shielded cable improves isolation.

Custom labeling makes cable ID a snap; no more tracing each cable when reinstalling a piece of equipment. The excellent return loss reduces disturbances to combiners and filters.

Pricing: \$25.90 in 1-4 quantity with "N" connectors

**Call for FREE APPLICATION NOTE: Using & Testing RF Cables**

# EAGLE

VOICE: (520) 204-2597

FAX: (520) 204-2568

PO Box 4010 Sedona, AZ, 86340

Circle (60) on Fast Fact Card

ing platform; SDI 7002 space-saving mount. <i>New Products</i> SDI smart docking station solutions. <b>Circle 375</b>	<i>New Products</i> Quickform, ver. 9 for FCC licensing. <b>Circle 383</b>	trunked mobile: HX585T 900MHz LTR trunked portable: GX5850T 900 MHz trunked mobile. <b>Circle 391</b>
<b>SEA</b> <b>Booth 1717</b> <i>Existing products</i> ESP1000 220MHz repeater; ESP504 220MHz mobile; ESP520 220MHz mobile; SEA700 220MHz hand-held. <i>New Products</i> ESP1100T ultra-linear high-power 220MHz transmitter; ESP520D mobile data transceiver. <b>Circle 376</b>	<b>Smartlink</b> <b>Booth 227</b> <i>Existing products</i> Smartlink universal trunking and networking products: sitelink digital multiplexer and crossconnect system. <b>Circle 384</b>	<b>STI-CO Industries</b> <b>Booth 1612</b> <i>Existing products</i> Disguised mobile two-way antennas including custom fender-mount models in lowband, highband, UHF, cellular/trunking and broadband frequencies; low-profile transmit antennas; couplers, tuners, dual-matched systems. <i>New Products</i> Superband Cellular Look-Alike UHF antennas, 400MHz-525MHz. <b>Circle 392</b>
<b>Selectone, see SmarTrunk Systems</b>	<b>SmarTrunk Systems, formerly Selectone</b> <b>Booth 1127</b> <i>Existing products</i> SmarTrunk II radio telephone trunking system. <i>New Products</i> Wireless local loop system. <b>Circle 385</b>	<b>Survey Technologies</b> <b>Booth 1654</b> <i>Existing products</i> STI-9100 mobile signal measurement and analysis system. <b>Circle 393</b>
<b>ServiceWare</b> <b>Booth 1749</b> <i>Existing products</i> ServicePlus series 2. <i>New Products</i> ServicePlus series 3. <b>Circle 377</b>	<b>SoftWright</b> <b>Booth 352</b> <i>Existing products</i> Terrain Analysis Package, radio propagation system design software; SiteBase, RF site management database software. <i>New Products</i> Five-digit U.S. zip code maps. <b>Circle 386</b>	<b>Tait Electronics</b> <b>Booth 1019</b> <i>Existing products</i> T800 series base stations and repeaters (66MHz-960MHz); T800 series paging transmitters and control links (VHF/UHF/800MHz); T2000 programmable mobile radios (VHF/UHF); Tait "Simulcast" systems. <i>New Products</i> Series II, T3000 (VHF/UHF) portable radios; mobile data terminal; mobile data transceiver/modem system; T2060 LTR trunked mobile radio. <b>Circle 394</b>
<b>Setcom</b> <b>Booth 241</b> <i>Existing products</i> System 900 single radio intercom; helmet kits; high-noise and lightweight headsets. <i>New Products</i> System 930 dual radio intercom; KA/KE helmet kits. <b>Circle 378</b>	<b>Solar Electric Specialties</b> <b>Booth 1153</b> <i>Existing products</i> MAPPS stand-alone solar electric power systems; Photogenet hybrid solar electric/genset power system; Solar/Cell sealed maintenance-free deep cycle batteries; Betrsolar rural telephone solar power system. <i>New Products</i> SES-MPR9400 remote monitor/control for solar power system. <b>Circle 387</b>	<b>Talley Communications</b> <b>Booth 1611</b> <i>Existing products</i> Distribution of over 100 product lines; services including system engineering, cut-to-length cable with connectors and filter product configuration. <i>New Products</i> Telemetry and spread-spectrum products. <b>Circle 395</b>
<b>SGS U.S. Testing</b> <b>Booth 1561</b> <i>Existing products</i> Independent testing laboratory providing compliance testing services, EMI-RFI-FCC; product safety; intrinsic safety testing. <b>Circle 379</b>	<b>SpaceCom Systems</b> <b>Booth 447</b> <b>Circle 388</b>	<b>TCC Industries</b> <b>Booth 1453</b> <i>Existing products</i> Coaxial connectors (TNC, N, mini-UHF, BNC, UHF, SMA, SAP); tools, strippers, battery eliminators; plug-in saver and saver/charger; lead-acid battery (VCR style); Liberty series Instant Hands-free dashboard mount. <i>New Products</i> Liberty series Instant Hands-free for Nokia 232 and 2120. <b>Circle 396</b>
<b>Sharp Communications</b> <b>Booth 1826</b> <i>Existing products</i> GE mobile radios; Telewave site management equipment; Whelen safety and warning signals; Samlex power supplies. <b>Circle 380</b>	<b>Spectrian</b> <b>Booth 646</b> <i>Existing products</i> Narrowband paging amplifiers; PCS amplifiers; SMR amplifiers; land mobile amplifiers; laboratory test amplifiers. <b>Circle 389</b>	<b>Tekk</b> <b>Booth 421</b> <i>Existing products</i> T-8 six-channel, 5W, VHF, synthesized, portable radios; T-80 12-channel, 5W, VHF, synthesized, portable radios; T-20 one-channel, 2W, VHF, crystal-controlled, portable radios; T-40 two-channel, ½W, UHF, crystal-controlled, portable radios; T-50
<b>Shure Brothers</b> <b>Booth 1741</b> <i>Existing products</i> Modulink mic series. <i>New Products</i> 596T hand-held mic. <b>Circle 381</b>	<b>Spectrum Communications</b> <b>Booth 341</b> <i>Existing products</i> Paging transmitters; high-stability frequency generator for simulcast; RF link transmitters and receivers; repeaters; high-power amplifiers and power supplies; transmit and receive modules; equipment for UHF, VHF, 900MHz, midband and 280MHz. <b>Circle 390</b>	
<b>Sinclair Technologies</b> <b>Booth 711</b> <i>Existing products</i> Base station antennas, combiners and multiplexers for trunking, paging, SMR, cellular and PCS. <i>New Products</i> Narrowband PCS products including the FP40207 HP and FP40605 HP filters; Excelsior line of mobile antennas, including 6dB UHF SUB4066 and wideband SVB1482. <b>Circle 382</b>	<b>Standard Communications</b> <b>Booth 1701</b> <i>Existing products</i> Convention and trunked two-way radio products including portables, mobiles, base stations, repeaters and accessories. <i>New Products</i> GX1510 UHF/VHF 10-channel conventional mobile; GX5800T 800MHz dual-protocol	
<b>Slattery Software</b> <b>Booth 645</b> <i>Existing products</i> FCC licensing software for FCC Forms 600, 402, 489, 494, etc.; software for generating proposals.		

## Expo

four-channel, 5W, VHF, crystal-controlled, portable radios; PCI-150A one-channel, 1W, VHF, crystal-controlled, portable radios; PCI-2WATT one-channel, 2W, VHF, crystal-controlled, portable radios; Terminator two-channel, 5W, VHF, crystal-controlled, portable radios; KS-900 T-Net Micro one-channel, 2W, UHF data transceiver; KS-960 T-Net Mini one-channel, 2W, UHF data transceiver with "Omni" can.

*New Products* \_\_\_\_\_  
T-9 and T-90 4W, UHF, synthesized portable

radios; PT-400 in-house paging transmitter and TP-450 UHF POCSAG pager; KS-1000 5W, UHF data radio; KS-2000 2W, 220MHz data radio.

**Circle 397**

**Telelink Technologies** **Booth 626**

*Existing products* \_\_\_\_\_  
DS5000 paging terminal.  
*New Products* \_\_\_\_\_  
DS5000 Micro 8 paging terminal.  
**Circle 398**

**Telepoint**

*Existing products* \_\_\_\_\_  
SR-20 point-to-point and SR-64 point-to-multipoint radio telephone link, lease line replacement and data radio.

**Circle 399**

**Booth 453**

**See ad page 78**

**Teletec**

*Existing products* \_\_\_\_\_  
Amplifiers, mobiles and microwave systems.

**Circle 400**

**Booth 217**

**Telewave**

*Existing products* \_\_\_\_\_  
M101 series transmitter combiners; receiver multicouplers; collinear antennas; exposed dipole antennas; yagi antennas.  
*New Products* \_\_\_\_\_  
TATC8944 autotune cellular transmitter combiners; ANT930Y 10-WR yagi antennas.  
**Circle 401**

**Booth 235**

**Telex Communications**

**Booth 101**

*Existing products* \_\_\_\_\_  
NH9000 tactical headset; ear mics; vehicle intercoms; light, medium and noise-attenuating headsets; listen-only devices; directly interfaceable headsets.

**Circle 402**

**Times Microwave Systems**

**Booth 1844**

*Existing products* \_\_\_\_\_  
LMR series cables; cable assemblies; connectors and prep tools.  
*New Products* \_\_\_\_\_  
EZ DIN connectors for LMR-900, LMR-1200 and LMR-1700 cables; EZ-400-NMH non-solder connector; new prep tools.  
**Circle 403**

**TPL Communications**

**Booth 209**

*Existing products* \_\_\_\_\_  
RF power amplifiers (35MHz-960MHz), mobile, base station and repeater models.  
*New Products* \_\_\_\_\_  
High-power 250W 800MHz-960MHz amplifier; updated packaging for HMS and LMS high-power amplifier series.  
**Circle 404**

**Transcrypt International**

**Booth 1441**

*Existing products* \_\_\_\_\_  
Embedded voice privacy and specialized signaling modules for land mobile radio users; cellular and wireless voice privacy; frequency hopping; computer-aided dispatch software; modular and PC-based mobile radio status reporters and telemetry products.

*New Products* \_\_\_\_\_

DME9600 dual-mode encryptor for APCO 25 portable radios.

**Circle 405**

**See ad page 3**

**Trident Micro Systems**

**Booth 201**

*Existing products* \_\_\_\_\_  
TNT LTR logic controller for 800MHz, 900MHz, 450MHz and 220MHz; CR-355 DID call router; DL-40 mobile data terminal; MP-7 ESN and over-the-air programming.

# TRIDENT MICRO SYSTEMS

MOBILE DATA, CONVENTIONAL RADIO AND SMR TRUNKING



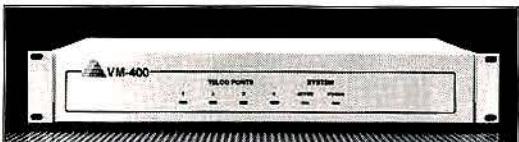
## TNT Logic Controllers

- Dispatch Networking
- Airtime Logging
- LTR® Compatible
- ESN Validation and
- Bi-lingual Prompts
- Remote Programming



## CR-355 Call Router

- Follow Me Roaming
- PBX Interface
- Least Cost Routing
- No Answer Transfer
- DID Interface



## VM-400 Voice Mail

- 1920 Minute Storage
- Direct Connect or Remote
- 2 to 8 Telco Ports
- 999 Mailbox Capacity



Trident Micro Systems

17951 Lyons Circle, Huntington Beach, CA 92647  
(714) 843-9300 (800) 798-7881 (612) 835-6383

Circle (62) on Fast Fact Card

# When Every Second Counts, Rely On Orbacom's TDM-150 CRT-Based Console System For Your Critical Emergency Communications Needs



Shown Above: The Lancaster County, Pennsylvania, 911 Communications Center With Orbacom's TDM-150 CRT-Based Console System.



Easy-To-Use Primary Operating Screen. Resembles Traditional Radio Channel Modules; Control Modules, As Well As Other Displays, Can Be Adjusted To Meet Your Unique Dispatch Operation Conditions.

As an established leader in the industry, with decades of experience in the design and manufacture of sophisticated communications consoles, Orbacom is the name to trust for your community's critical emergency call and response situations. Orbacom's new generation of TDM-150 Communications Control Consoles is not only state-of-the-art, but also sets the stage for efficiently expediting your immediate emergency communications needs, as well as effectively fulfilling your ever-expanding future response requirements. Some outstanding features of Orbacom's TDM-150 include Multi-Level Trunking Interfaces, On-Line Screen Changes,

"Drag & Drop" Instant Screen Creation, Multi-Function Screen Grid, On-Screen Alarm Notifications, Windows™ Applications and many more user-friendly operations. The ultimate bottom line is that you and your community will appreciate knowing that when it comes to protecting life and property, you can depend on Orbacom's technology to help you transmit vital instructions, *when every second counts*. For more information, please call or fax in your request for free literature: 609-829-4455/fax:609-829-6980.

Circle (63) on Fast Fact Card

# 9-1-1



1704 Taylors Lane, Cinnaminson NJ 08077 Tel: 609-829-4455 Fax: 609-829-6980

Windows is a registered trademark of Microsoft, Inc.

## Expo

### New Products

Digital Passport advanced trunking with digital interface to wireless systems; MK-86 mobile disable over-the-air.

Circle 406

See ad page 66

### Trilogy Communications

Booth 142

#### Existing products

MC2 coaxial cables (50V/75 V); RMC2 radiating cables (50V/75 V); connectors.

Circle 407

See ad page 25

### Tru-Connector

Booth 736

#### Existing products

Standard and custom RF coaxial connectors for 7/16, HN, N, QC, SQ, LC, LT, EIA, QDL, C, SC, QDS, Twinax, BNC, TNC, UHF, SMA, BSM, TSM, MB and Triax.

#### New Products

All configurations of high-power 7/16 connectors; Super Quick high-power connector.

Circle 408

### TWR Telecom

Booth 634

#### Existing products

Tower engineering and construction service; communications equipment sales and installation; tower lighting and monitoring equipment; medium-intensity strobes; red code beacons; single and double obstruction lights; complete light kits.

Circle 409

### TX RX Systems

#### Existing products

Multicouplers; signal boosters; duplexers; filter; RF system products; associated hardware.

Circle 410

Booth 1711

See ad page 48

### Uniden America

Booth 1201

#### Existing products

Land mobile radios, portables, mobiles and repeaters.

#### New Products

SPS335TSD 800MHz full-duplex portable; SPH21/SPU21 UHF/VHF portable; SVS8025TS 800MHz mobile; SS11P1001 rural telephone interface.

Circle 411

See ad page 60

### U Trunking Repeater/ Mountain Relay

Booth 1960

#### Existing products

Five-channel UHF (460MHz) LTR trunking repeater system with telephone interconnect.

Circle 412

See ad page 88

### Valmont Industries/Microflect

Booth 1716

#### Existing products

Tapered steel monopoles to 250ft; tapered steel camouflaged sites; self-supporting towers to 400ft; guyed towers to 600ft; passive repeaters; waveguide supporting systems and components.

#### New Products

Roof mounts, wall mounts and transmission line supports for PCS sites.

Circle 413

See ad page 29

### VCP International

Booth 658

#### Existing products

Panasonic EX and EZ pagers; Motorola paging products and accessories; Panasonic batteries.

#### New Products

Panasonic Octiva synthesizer pagers models EP-2L2, EP-2L4 and EP-2L5; Samsung SRP-5400A four-line alphanumeric pager; Samsung SRP-5210N side-mount numeric display pager; Samsung SRP-5600 top-mount numeric display pager.

Circle 414

### Vega, A Mark IV

Booth 1729

#### Existing products

Series 5000 communications consoles; tone and dc remotes.

#### New Products

TC560 and TRA260 trunking consoles.

Circle 415

See ad page 1

### Vertex Radio Communications

Booth 901

#### Existing products

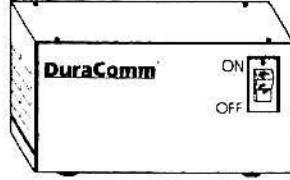
Commercial two-way mobiles, portables, repeaters and base stations.

#### New Products

VX-FTL-1011H lowband mobile (110W and

## New! 22 Amp Desktop Supply

- Auto Reset
- Super Quiet
- 6" x 5.5" x 3.5"
- Less than 3 lbs.
- ESD Safeguard



- 110/220 Switchable
- Thermo Cooling Fan
- AC/DC Line Filtering
- Illuminated Power Switch
- MOV Line Input Protection
- Overvolt/Current Protection
- 22 Amps Continuous Output

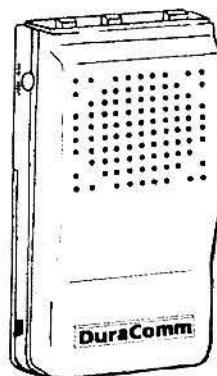
7, 11, 15 Amp Models Also Available  
All Continuous Rated

**DuraComm/TPS Power Supplies**

Kansas City, Mo.

Or contact your Communications Distributor

## Voice Paging & Scanning Monitor



- 2 Channel with Monitor Scan
- User Selectable Priority
- Program up to 3 Individual Addresses on Each Channel
- No Reeds - Major 2-Tone Formats - PC Programmable
- Decode on Both Channels - Auto or Manual Reset
- Vibrator Option with Message Alert - Low Battery Alert
- AA Cell or Nickel Cadmium Packs - Charger/Amplifiers

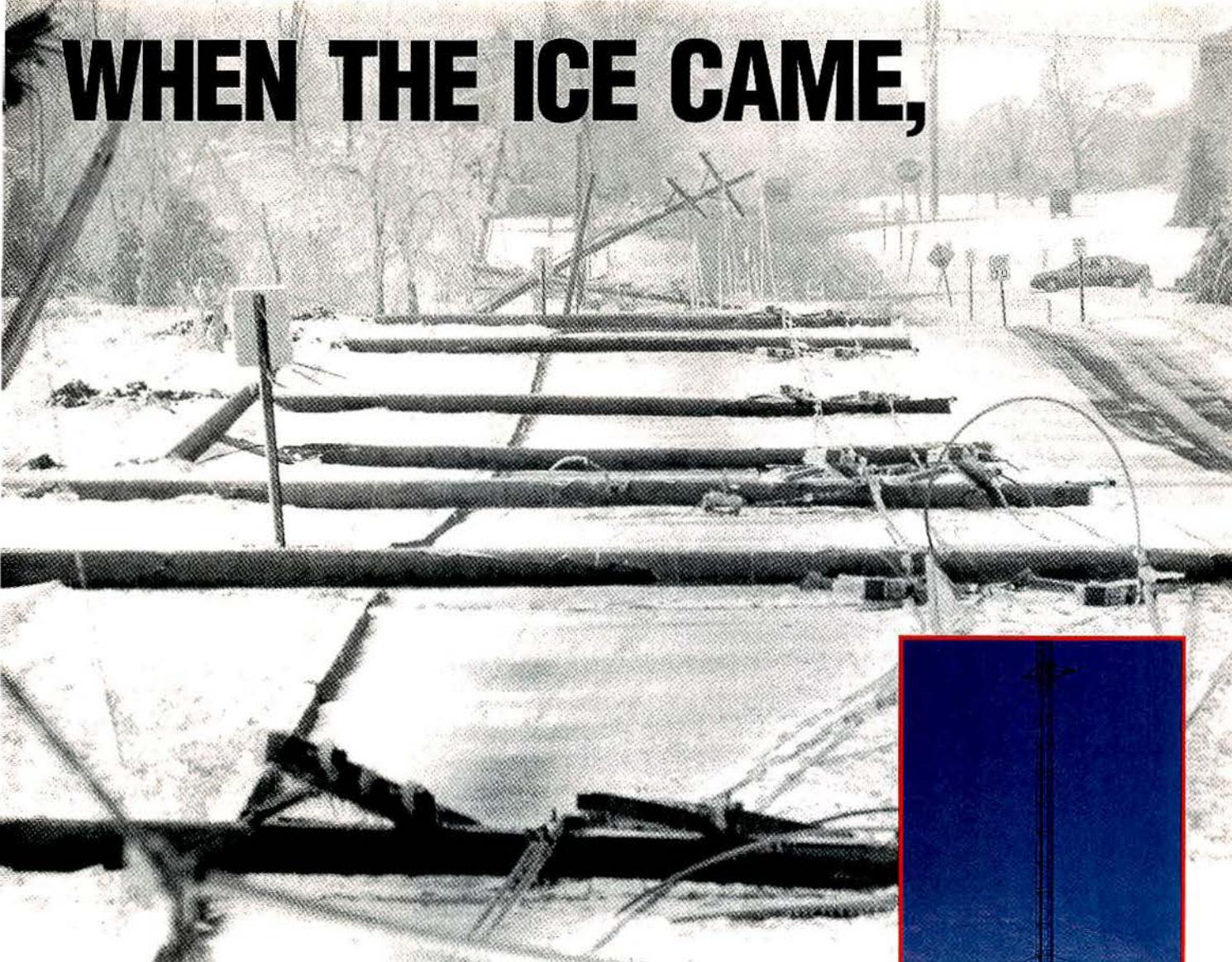
The New Voice in 2-Tone Paging

**DuraComm Corporation**

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Fax 816-741-7499

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## OUR PiROD TOWER DIDN'T EVEN SHIVER.



Dave Turner  
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Indianapolis, Indiana

"With more than two feet of ice at the antenna of our 1,000-foot PiRod tower, and guy wire ice eight inches in diameter, our tower bent like a banana. I recall my engineer saying that the tower wouldn't last five more minutes. But our solid rod PiRod tower stood there and straightened as the ice melted. No damage. No stress fractures. No problems. I guess that's when the quality of a solid rod PiRod tower comes through."

*Solid Rod, Solid Service, Solid Value*



***Solid rod, free-standing or guyed towers custom designed to your specifications.***

For a free guide to tower selection and fast, courteous response to your requests for quotation, contact:



**PiROD INC.**

P.O. Box 128  
Plymouth, Indiana 46563-0128  
Telephone (219) 936-4221

## Expo

60W), in four-, 24- and 99-channel versions; System 600 commercial HF/SSB transceiver.  
**Circle 416**

*See ad page 81*

**VertiCom** **Booth 123**

*Existing products*

MTS 1000 frequency synthesizer for satcom applications from 20GHz-18GHz; MTS 2000 frequency synthesizer for IMDS/LVDS applications.

*New Products*

MTS 3000 frequency synthesizer with IF 2.0 for satcom applications; MTS 1019 frequency synthesizer for point-to-point communication.  
**Circle 417**

800MHz-960MHz 400W amplifier; VHF broadband amplifier.  
**Circle 418**

*See ad page 89*

**VoCom Products** **Booth 755**

*Existing products*

800MHz, 140W amplifier; 956MHz, 120W amplifier; VHF amplifier; UHF amplifier; mobile amplifier.

*New Products*

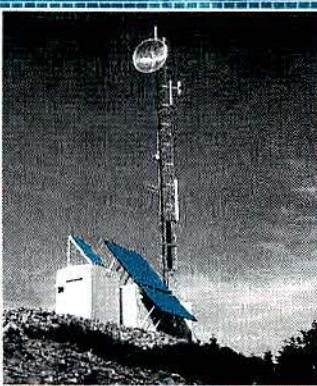
**W&W Associates** **Booth 1841**

*Existing products*

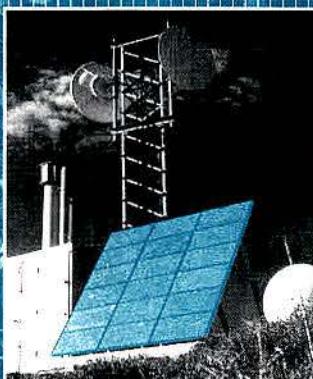
Replacement batteries; chargers; accessories. *New Products* Replacement batteries for Vertex/Yaesu VX200, VX500 and FT10/40R, Motorola Visar, HT1000 and P110, Standard HX580, Icom IC-U81T and IC-T22A, Kenwood TK250/350, Kyodo 109 and 209, E.F. Johnson Viking XR, and Midland 70-148; expanded line of master chargers and analyzers.  
**Circle 419**

*See ad pages 32A, 49*

## The Power to Communicate anywhere under the Sun...



- **Cellular Enhancers**
- **Microwave repeaters**
- **Telemetry/**
- **Data Acquisition**
- **Mobile radio**



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Circle (66) on Fast Fact Card

# The Winning Combination

## Sinclair's Tower Top Amplifiers/Receiver Multicouplers and Transmitter Combiners

Come see us at!  
IWCE  
booth #711

### RM-43020/TTA

This family of multicoupling equipment incorporates a tower-top amplifier and an active receiver multicoupler for enhanced performance in congested environments, and whenever unacceptable loss is encountered in long feed cable runs. All units are equipped with surge arrestors for lightning protection, while many versions provide system redundancy.

### RTC\*-800 Series

These compact transmitter combiners utilize Res-Lok™ construction and high-performance dual isolators in a configuration that assures easy expandability and field tuning utilizing the test ports provided. Developed for operation in the 851-866 trunking frequency band, these highly versatile combiners are available in expandable 5- and 10-channel models, and a fully expanded 20-channel version.



Ask us about our narrowband  
PCS/PCN product line

Celebrating our 45th anniversary as a major innovator and manufacturer of high quality mobile and base station antennas, transmitter combiners, receiver multicouplers, duplexers, and cavity filters for the wireless communications industry.

## SINCLAIR

For complete specifications and information on Sinclair's full product line-up phone or fax today.

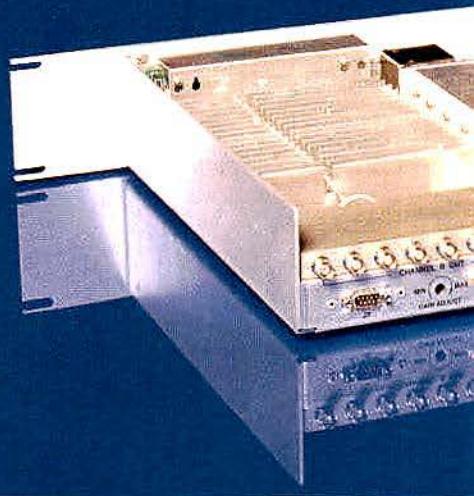
**Sinclair Technologies Inc.**, 85 Mary Street, Aurora, Ontario, Canada L4G 6X5 Tel: (800) 263-3275 Fax: (905) 727-0861  
55 Oriskany Drive, Tonawanda, New York 14210, U.S.A. Tel: (800) 288-2763 Fax: (716) 874-4007

**Sinclair Technologies Ltd.**, William James House, Cowley Road, Cambridge, CB4 4WX U.K. Tel: +44 (0) 1223 42 03 03 Fax: +44 (0) 1223 42 06 06

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For Demanding  
AMPS, TDMA, and CDMA –  
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**RECEIVER  
MULTICOUPLERS**



PLUS Off-the-Shelf, One-Day Shipment of Critically Needed Components

Type N High Power Directional Couplers for Tx and CDPD Requirements



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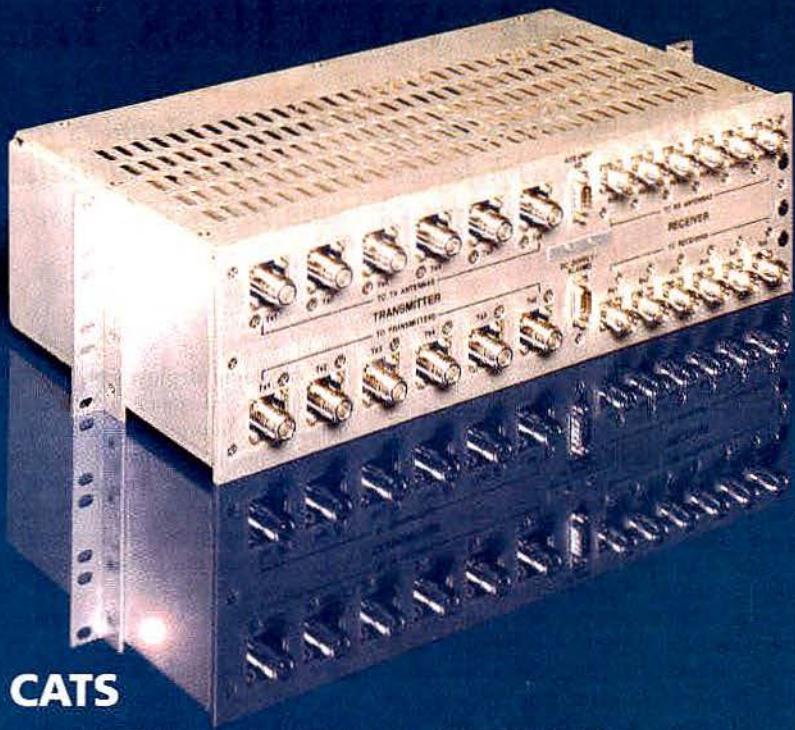
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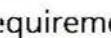
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# Powering the new wave of wireless networks

*With "wireless energy," network planners have greater versatility in site selection with fewer "out-of-plant" liabilities, reduced site development requirements and lower risk of service interruption.*

By Nelson E. Stevens

Wireless communications infrastructures are rapidly moving away from urban centers to serve rural customers. Quite often, rural areas do not have access to utility-grade, grid-connected power, forcing telecommunications system operators to design, install and maintain their own power generation facilities. How will operators power these new wireless networks in remote locations, and how will power affect operating costs and network reliability?

A new generation of renewable energy products and services has been developed as the "wireless energy" solution to the new wave of global wireless networks. By shifting to solar or wind energy as the primary power source, operators can use this technology to satisfy many of the needs of modern telecommunications op-

erations: rapid deployment, high reliability, low maintenance and fuel requirements, and future expansion capabilities. Network planners welcome these technologies as a cost-effective means of deploying transmission and distribution infrastructure in rural areas where utility power access may be too far away or the supply may be unreliable.

The object of wireless energy technologies is to minimize dependence on external resources, such as manpower, equipment and fuel, to support remote sites. By reducing these dependencies, site reliability is dramatically improved, and fuel, maintenance and transportation costs are kept to a minimum. Improved site autonomy is a wise design goal, particularly in developing economies where the potential for natural disasters combined with weak response capabilities jeopardizes network integrity.

Three standard system architectures rep-

resent "wireless energy" solutions: hybrid (combined wind and solar power) for larger wireless applications (>650W); solar power alone for smaller power requirements (<650W); and "cycle charge" for locations where renewable energy sources are unavailable or unpredictable. The advantages of all these remote power solutions are bolstered by remote power monitoring software.

## Hybrid systems

One particular prepackaged renewable energy-based hybrid system, designed specifically for off-grid wireless applications

Stevens is an independent telecom energy systems consultant in Santiago, Chile. He formerly was director of telecom sales for New World Power Technology, Moretown, VT. Comments about this article can be sent to email: wireless@together.com

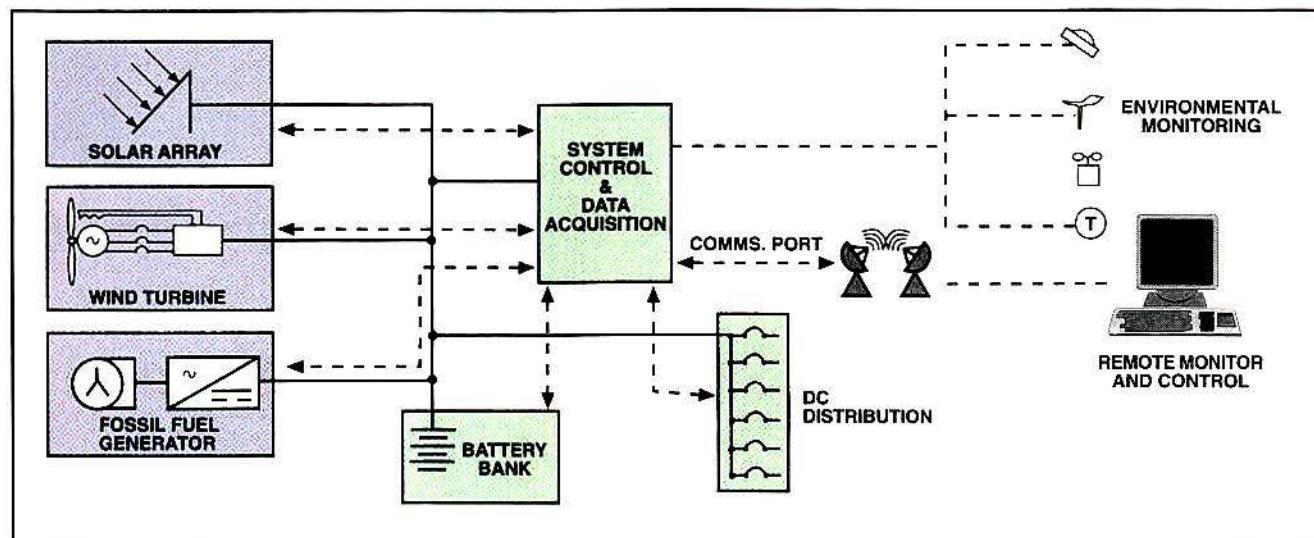


Figure 1. A prepackaged, renewable energy-based hybrid system, designed for off-grid wireless applications with average continuous communications loads of 650W to 4,000W, uses wind or solar energy for primary power and a fossil fuel engine generator for backup or supplemental capacity.

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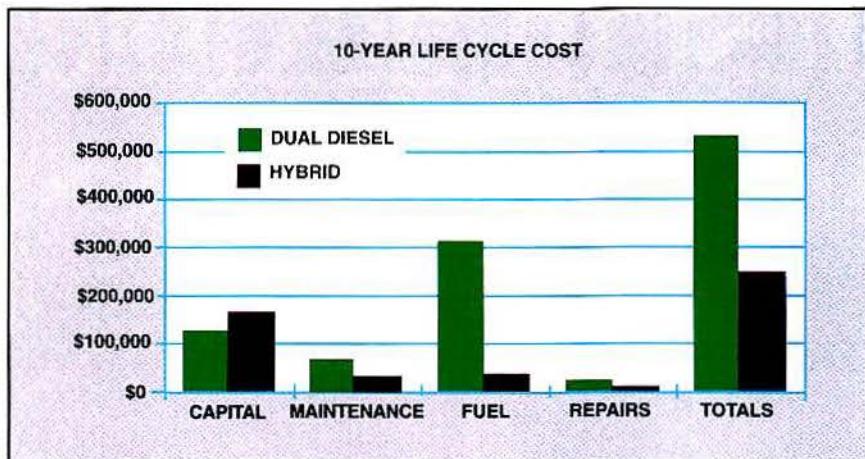
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**Figure 2.** Lower annual fuel and maintenance costs translate into significant project lifecycle savings. This chart compares expenditures in capital, maintenance, fuel, repairs and total life-cycle costs for hybrid and dual-diesel systems. By the 10th year of operation, with a fuel cost of \$2/gallon, the hybrid system saves the operator about \$300,000, after a payback period of two years.

with average continuous communications loads of 650W to 4,000W, uses wind or solar energy for primary power and a fossil fuel engine generator for backup or supplemental capacity. Figure 1 on page 74 shows the system's fundamental building blocks.

Deployment is streamlined by pre-

assembling and testing systems at the factory to minimize field installation requirements and to enhance reliability. The complete system is integrated within an environmentally controlled, transportable shelter with provision to house additional communications equipment.

This hybrid architecture is inherently

more reliable than continuously run fossil fuel generators because of its multi-source energy supply, long-term battery autonomy (two-to-three days) and use of industrial-grade microprocessor controls that can be remotely monitored and controlled. Hybrid systems can accommodate load expansion by automatically increasing engine run time to supplement power on demand. Because of the hybrid's flexible power range, the renewable energy elements do not have to be sized for worst-case conditions (peak communications traffic; heating, ventilating and air conditioning [HVAC] system operation; or long periods of low renewable energy output). Therefore, to serve large loads, capital costs for hybrid systems are comparatively less than for single-source renewable energy systems.

The true savings from the hybrid approach becomes clear from a review of operating costs. Continuously run diesel generators, for example, consume about 6,000-12,000 gallons of fuel per year and require engine overhauls every four years (40,000 hours) of operation, simply to support a 1,500W load. In contrast, a comparatively sized hybrid system burns

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only 500–1,000 gallons (depending on renewable resources) and accrues less than 1,500 hours per year. For maintenance, the hybrid system typically requires only one man-day of service per year, compared to six man-days for diesel generators.

Lower annual fuel and maintenance costs translate into significant project lifecycle savings. Figure 2 on page 76 shows the relative expenditures in capital,

maintenance, fuel, repairs and total life-cycle costs for the hybrid and the dual-diesel systems. By the 10th year of operation, with a fuel cost of \$2/gallon, the hybrid system saves the operator about \$300,000, after a payback period of only two years.

Delivered fuel cost is one of largest determining factors affecting total site life cycle costs for power generation. Depending on the site, delivered-fuel cost

can range from \$1–3/gallon.

#### Solar only

An alternative is to use a single renewable power source, solar energy, to support communications without the use of a backup engine generator. A single source is ideally suited for wireless communications applications requiring less than 650W average continuous power. Because solar systems do not require fuel, they are often less expensive to operate and to maintain than hybrid or dual-diesel alternatives.

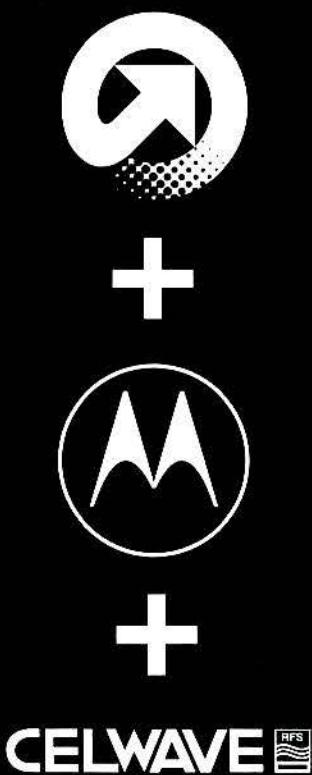
One type of solar system is pre-assembled at the factory with integrated enclosures to simplify deployment. The solar array is often installed on top of the system enclosure to eliminate extra foundation work and to shade the power equipment. Another integral design feature is passive cooling technology that mitigates extreme temperature conditions that affect charging performance and battery life.

The cost to operate and maintain solar systems is minimal. Typical annual maintenance includes cleaning the solar array, checking battery voltage and inspecting the site.

Applications for solar power systems encompass almost every facet of the wireless marketplace. Within the cellular network, large solar systems are ideally suited for mountaintop cellular repeaters that could link solar-powered cellular pay phones along highways or within rural villages. The almost unlimited access to remote territories via earth-orbiting communications satellites supports using solar power for remote industrial supervisory control and data acquisition (SCADA) applications and rural phone offices. Where long-distance fiber links cross extremely remote areas, reliable power must be provided every 20–40km for signal regeneration. Finally, rural telephony projects that use point-to-multipoint radio networks commonly use solar energy at most, if not all, of the repeater and subscriber sites to streamline network deployment.

#### Cycle charge

In the absence of "fuel-saving" renewable resources (wind or solar) at remote sites (higher latitudes, for example), there is one other system architecture worth considering before moving to continuously run diesel generators or miles of expensive grid extension. Cycle charge systems operate a fossil fuel generator intermittently (15–40% run time) to recharge a large battery bank which provides continuous current to the load. By discharging the battery to 40–60% DOD, engine run time, maintenance and fuel use are kept to a minimum. The logic is simple: Fossil fuel has a much



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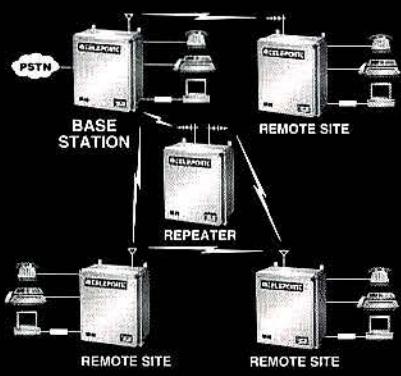
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higher energy density and cost than the battery plant. By cycling the generator and storing energy in the battery, energy efficiency is maximized.

The advantages and disadvantages of cycle charge systems, compared to renewable energy-based systems are quite obvious. The cycle charge unit does not require as much site-specific planning because it is independent of wind or solar resources, and it requires "regular" engine mainte-

nance that is well understood by telecom service workers. The disadvantages of cycle charge include higher fuel usage, battery change-outs and engine maintenance than renewable-based systems.

#### Field examples

► **GTE/Codetel, Dominican Republic** — In 1991, a wind-solar-diesel hybrid system was installed to provide 1,000W of electricity to a mountaintop microwave re-

peater station. The system receives about 60% of its energy requirements from the 3kW wind turbine and 6kW solar array, resulting in engine run time of only 1,255 hours per year. Maintenance and fuel requirements were reduced by 80% compared to traditional dual-diesel generators.

► **AT&T, Bolivia** — AT&T World Services used solar-diesel hybrid systems to power each of its 17 mountaintop repeater sites between Santa Cruz and Quijarro, Bolivia, in 1990. On average, the hybrid systems reduced fuel requirements by 75% where anticipated delivered fuel costs were US\$1 per liter. Site service is performed biannually.

► **Sprint, Nevada** — Sprint installed a stand-alone solar system to operate a remote fiber-optic regeneration site in 1990. The system uses a 5kW solar array to displace precious fuel, which is nearly impossible to deliver across 4km of treacherous road.

#### Remote power monitoring software

The remote power monitoring software allows a personal computer to monitor and control power system performance, to display graphics on a cathode-ray tube (CRT) and to schedule maintenance for a multitude of locations. Remote monitoring software products vary in degree of capabilities and sophistication ranging from simple alarm functions to Windows-based viewing screens to help evaluate discrete functions and histories within each power system in the network.

This type of program is extremely valuable to network operators who want to diagnose power system problems before dispatching service employees to remote locations. Furthermore, the software can notify operators of upcoming maintenance requirements according to actual site conditions, such as the engine run time and fuel reserves.

#### Wireless energy's market implications

Within the new wave of wireless networks, hybrid and stand-alone solar technology will affect the way communications sites are deployed and serviced. No longer tethered to the electric utility grid, network planners will have greater versatility in site selection. The advent of wireless energy technology will undoubtedly create similar advantages to those found with wireless communications:

- fewer "out-of-plant" liabilities.
- reduced site-development requirements.
- lower risk of service interruption.

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# The FCC's 800MHz auction: Why it won't work

By Robert H. Schwaninger Jr.

On Dec. 15, 1995, the Federal Communications Commission released its decision on 800MHz auctions. Members of the commission said at the open meeting that the rulemaking had been contentious, but that they believed the agency's decision within the rulemaking formed the best possible solution for regulation of this portion of the spectrum.

Commissioner James Quello said incumbent operators who opposed auctions were trying to "wind back the clock" to pre-auction days. Some other commissioners claimed that they still had concerns about the effect of mandatory relocation. All in all, the comments from the dais sounded much like a committee of baseball managers talking about releasing a favorite player. You could almost hear Tony La Russa saying, "The club has decided it's going another direction and Gilkey just doesn't fit into our plan."

What is that plan? Will that plan work? Those are the questions one asks time and again while reading the voluminous *Report and Order* in Docket 93-144 and the *Further Notice of Proposed Rulemaking* that are the byproducts of the FCC's action on Dec. 15. After more than a month of reading and analyzing those documents, objective analysts must agree that the plan will not reach the stated objectives within the *Report and Order*.

## The stated objectives

A patient reading of the *Report and Order* reveals the justifications given for mandatory relocation and those that support the size of channel blocks to be employed by Economic Area (EA) licensees. In sum, they are:

□ to create continuous blocks of spectrum at 800MHz that are sufficiently wide

Schwaninger, MRT's regulatory consultant, is a partner in the Washington, DC, law firm Brown and Schwaninger and is a member of the Radio Club of America. He is the author of "Day of Reckoning," a report to the National Telecommunications and Information Administration regarding the use of spectrum by companies to forestall a demand for profit accountability.

to enable EA licensees to employ wideband technologies, such as spread spectrum, in future uses.

□ to ease the administrative burden on the FCC that arises out of geographic-specific licensing, like the present system.

□ to create larger, more design-flexible systems to compete directly with cellular carriers and now, personal communications services (PCS) carriers in the marketplace.

*The FCC is not really "auctioning" spectrum this time. What they are selling is a license to maybe use spectrum if you can come up with the comparable spectrum to relocate existing users.*

□ to provide small business and rural telephone systems an opportunity to participate in auctions and the provision of competitive services across EAs.

□ to create regulatory parity, as between specialized mobile radio (SMR) system operators and cellular system operators and now, PCS system operators.

□ to fulfill the alleged mandate to employ auctions as a means of accomplishing the foregoing, thereby collecting revenue for the U.S. Treasury for use of the radio spectrum.

The six objectives appear again and again throughout the *Report and Order*, to justify variously, as the FCC deemed appropriate, each element of its decision. The list provided above is in no particular order of importance to the FCC as its decision reads. However, the question remains whether the FCC's new regulatory regime will produce the stated objectives.

## The prize

If an entity is victorious at the 800MHz auction, it gets—what? Under the present

decision in the *Report and Order*, the winner gets the right to operate across a large geographic area on a block of contiguous 800MHz spectrum, either 120 or 60 or 20 channels wide, provided that the winner can clear the spectrum of existing users by exchanging "comparable spectrum" with operators who hold licenses for auctioned spectrum within that area. Where such contiguous channels are not presently licensed, the winner gets them.

A review of the FCC's license database would reveal that the chance of finding the oldest 200 SMR channels unlicensed across an entire EA is roughly equivalent to my chances of playing left field for the St. Louis Cardinals—zip. Therefore, the FCC is not really "auctioning" spectrum this time. What they are selling is a license to *maybe* use spectrum if you can come up with the comparable spectrum to relocate existing users. In the words of the bard, "Aye, there's the rub." Stated in a manner that is somewhat clearer than the FCC's decision, you gotta have spectrum to give spectrum to get spectrum.

This condition to the creation of EA-wide SMR systems which employ contiguous spectrum blocks is a nagging problem undermining nearly all of the stated objectives. Yet, this problem is barely addressed in the FCC's decision, except for the FCC's statement that if an auction winner is not able to offer comparable spectrum, the winner forfeits its right to relocate existing users, thus forfeiting its right to operate across a contiguous block.

## Contiguous blocks

Reasonable people might disagree about whether the creation of contiguous blocks of spectrum is a necessary goal. As anyone familiar with trunking technology knows, a highly efficient system can be designed without any such requirement. Ask any 20-channel SMR trunked station operator whether its system is delivering efficient services to the public, and you are likely to hear a positive response. However, the FCC appears to be convinced that traditional trunking technology is just not good enough. Now it wants to push the envelope and demand that even greater efficiencies be produced

regulatory fiat, the vital competitive energies of Joe's system in Joe's market providing Joe's services at Joe's prices, is found wanting. The FCC has decided that Joe simply cannot compete or that his contribution to competition is unimportant. This is news to Joe. This is news to anyone who is involved in the SMR industry.

What the FCC is really saying is that Joe cannot compete across the entire EA employing the latest technology to provide a service that is akin to cellular service. The FCC's decision is equivalent to declaring that a local UHF-TV system is a nullity if it cannot provide a signal beyond a limited geographic area. The FCC never explains why it deems it important to provide facilities for locally produced broadcasts (dependent only on the advertising revenue that can be gleaned from their individual markets), but it is not important to have local two-way carriers.

Even if an EA auction winner obtains authority for all 200 channels, the delay and cost of relocation of incumbent systems, combined with the cost of building the system, then marketing it against entrenched competition such as cellular, places that operator at such a disadvantage in the marketplace that the chances of operating a profitable system are non-existent. Joe of Peoria's system is presently competitive and profitable. The EA winner's system is bigger, snazzier and politically correct, but it's a lousy investment for anyone who likes to see positive earnings.

So what kind of competition for cellular carriers and PCS permittees has the FCC created? At best, it is extremely weak competition in the form of EA licensees. Worst of all, the agency is curtailing or destroying the most effective competition that cellular carriers have to face: the local SMR operator who provides good, cost-effective dispatch service to a grateful public.

#### Small business

In its decision, the FCC trotted out the now-standard breaks for small business: bidding credits and easy-pay plans that are better than those you can get at any bank or used car lot. Those benefits are pretty attractive, and enticed some small businesses to participate in the 900MHz auction, but the FCC has not considered the real cost of participation that arises out of the relocation process.

Small businesses (those with less than \$3 million in gross revenue) simply cannot afford the cost to relocate other operators. (In the past, they also could not afford the cost of licensing and constructing an ESMR system for the purpose of warehousing spectrum to use in the future.) They cannot afford to buy out their

neighboring systems to gain the spectrum. They cannot afford to bully anyone off of the channels so that they can use them. In sum, they simply cannot afford to play.

The FCC decision does not recognize this fact. It concentrates solely on the cost of auction participation and not on the cost of being positioned to use what might be acquired. The FCC's approach is like giving great discounts on automobiles for anyone under the age of 10. Creating

greater economic access to the auction process is a wonderful idea, but just giving small business an alleged bargain from government is not a realistic appreciation of the economic dynamics of the market. Therefore, the FCC's objectives regarding small business simply cannot be met.

#### Regulatory parity

The mantra "regulatory parity" has been echoing through the halls of the FCC

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for about three years. When Commissioner Quello stated during the Dec. 15, 1995, opening meeting that SMR operators in opposition were trying to "wind back the clock," he was really saying that the demands of regulatory parity require that the commission move forward toward market-based licensing for SMR systems.

In its simplest form, regulatory parity requires that the FCC take steps to level the regulatory playing field between like

operators. So, if the FCC gives a break to cellular operators, they are supposed to give a break to PCS operators and so on. Employing these magical words, regulatory parity, Nextel Communications has forwarded its agenda to promote 800MHz auctions, saying in effect, "We are more like a cellular system, so we should be treated like a cellular system."

What Nextel and the FCC seem to be ignoring is that the regulatory regimen put

forth by the recent decision bears no resemblance to the one that created market-based cellular licensing. The existence of licensed operators on the relevant spectrum whose livelihoods depend on the use of that spectrum creates public interest considerations that were not present in the cellular licensing plan. Those existing operators thus deserve their own brand of regulatory parity, if they are to be made to accommodate Nextel's demand for parity with other large operators.

It makes no sense to suggest, as the FCC has, that to provide regulatory parity to EA auction winners equates to regulatory parity for existing operators. If the goal of regulatory parity is to level the regulatory playing field among like competitors, then such leveling should have begun long ago in the SMR field, preventing the creation of the spectrum warehouses known as ESMRs. Because the FCC did not then act to curb the voracious appetites of ESMR operators as they speculated and warehoused literally thousands of channels across the country, it is incumbent on the FCC to correct its past error of omitted regulation before giving additional benefits to the entities and persons who created this inequity via speculative licensing.

To provide true regulatory parity, the FCC should first unload the spectrum warehouses, then consider an auction scheme that does not directly reward the entities that operated those warehouses. If that suggestion is "winding back the clock," then so be it. When the agency has made repeated mistakes that have caused great harm to a vital, competitive industry, it should demonstrate fidelity to its duty and correct those harms to the best of its ability. It should not say, in effect, "What's done is done," without apology or explanation. This rulemaking was an opportunity to make amends. Instead, the FCC is excusing and ignoring its past failures. The least that the FCC might do is admit that the objective of regulatory parity is not met for all SMR operators—only for the very, very few.

#### Auction mandate

This final objective is the least likely to be realized. As shown above, few entities are positioned to reap any benefit from participation in the auction. The post-win costs are so high, and the assembling of contiguous spectrum through relocation is so complex, that the amount of revenue to be realized from this auction cannot possibly justify the agency's bothering to begin the bidding.

The FCC has stated that this objective is the one with the lowest priority. In a hint of logic, the commission has stated that the raising of revenue for the U.S.



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Treasury is not the motivating factor in these proceedings. This is understandable, considering that many persons are predicting that it is unlikely that most channel blocks, particularly the largest, will have more than one bidder—Nextel. It is then likely that the commission will simply award the auctioned authority to Nextel without further delay or farce.

Even assuming that the regulatory regimen created by the FCC's decision might be left standing, following reconsideration and likely court challenge, one cannot help but wonder why the FCC seems to believe that awards of licenses must be by auction. There is nothing within the Communications Act that removes the FCC's ability to employ comparative hearings, lotteries, first-come-first-served, or any number of other methods for selection among applicants.

Conspicuously missing in the FCC's auction participation criteria is any preference for existing operators. One might think that a small business that has demonstrated its commitment to a particular market through construction and operation of SMR facilities might be rewarded by some preference. The FCC did not see it that way.

The commission's compulsion in employing auctions as its method of selection is therefore, mystifying. It admits that it doesn't expect to make much money. It even admits that it does not expect to receive competing bids for all (or most) EA channel blocks. These admissions alone suggest that the FCC knows what the rest of the industry knows. The stated objectives of the FCC's decision cannot be met because the FCC has not created a level playing field among potential participants in the auction.



**Cards on the table**

Government works best when our leaders are forthcoming in their analyses, motivations and agendas. Then the public can appreciate the nature of regulation and law. The following statements are offered as suggested inclusions in the FCC's response to the inevitable petitions for reconsideration to this matter. The FCC may use them to explain the new regulatory plan for 800MHz in a way that is more intellectually honest:

◆ We now understand that the licensing scheme won't work as stated, but the train has left the station—  
and we don't have the political will to reverse it.

◆ We still don't have the will to stop application mills—  
speculators, spectrum warehouses, and all of the other people looking to make a fast buck.

◆ Yes, small business has no chance of meaningful participation in offering service across EAs—but we don't care.

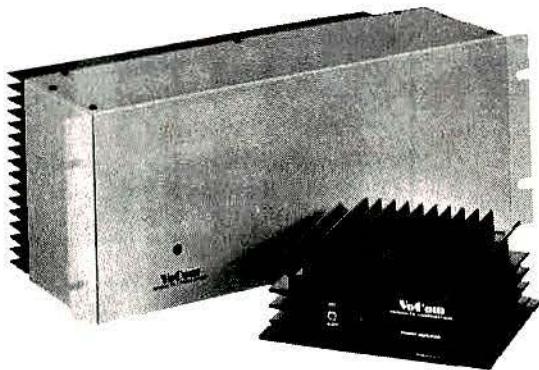
◆ We're still waiting for someone to define "comparable spectrum"—  
and then find it.

◆ When we said regulatory parity—  
we meant among publicly traded telecommunications giants.

◆ We're going to cancel the finder's preference program without public notice and comment in a rulemaking proceeding—  
because it might be used against EA operators.

**JOKER**  
We hereby officially refuse to explore the possibility that maybe, just perhaps—  
we blew it.

—Robert H. Schwaninger Jr.



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## Technically speaking

(continued from page 8)

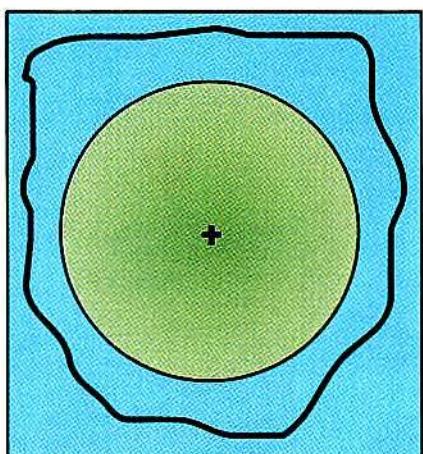


Figure 4. When the desired service area is round and the base station antenna is in the center of the area, an omnidirectional antenna pattern is needed. The green circle indicates the coverage pattern.

antenna, carefully consider the service area to be covered. At what point within the service is the antenna to be located? What is the general shape of the coverage area? These factors play an important role

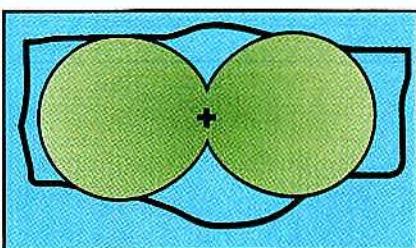


Figure 5. When the service area is elongated and the base station antenna is in the center of the area, a horizontally collinear antenna works well. It produces a figure eight pattern. The sharpness of the nulls can be reduced by a special design to fill in the side areas.

in the antenna choice. In Figure 4 at the left, the area to be served by the base station is fairly round, with the antenna located near the center of the service area. The choice here is simple—an omnidirectional antenna should be used with the necessary gain to adequately cover the area.

In Figure 5 (above center), the service area is elongated with the antenna located at the center of the service area. What kind of antenna? A *horizontally collinear antenna* may be the best choice. A horizontally collinear antenna consists of two vertical radiators spaced at a horizontal

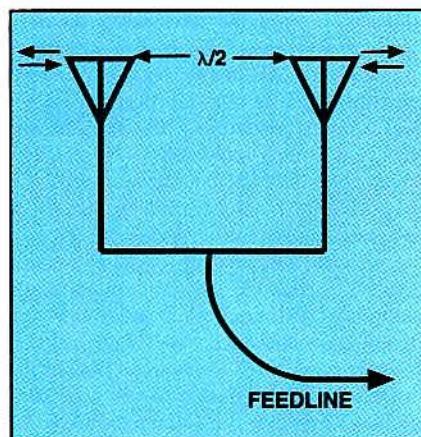
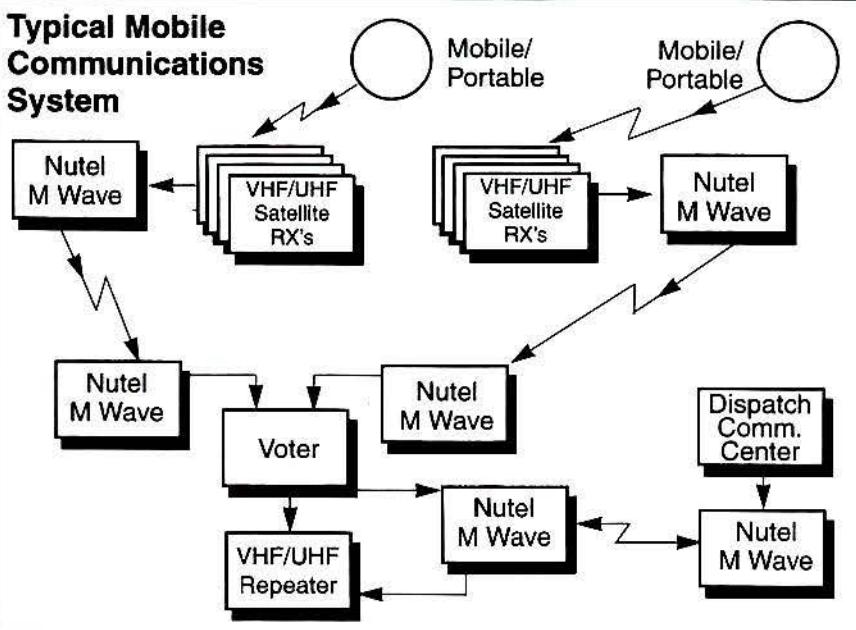


Figure 6. The horizontally collinear antenna is composed of two vertical radiating elements placed  $\lambda/2$  apart and fed in phase. Radiation to the sides is nulled, while the radiation in the desired directions is reinforced.

distance of  $\lambda/2$ . This causes the radiation to cancel in the directions of undesired coverage and to reinforce in the desired directions (See Figure 6 above.) By special design, the sharp nulls can be reduced somewhat to provide some side coverage as needed.

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## Technically speaking

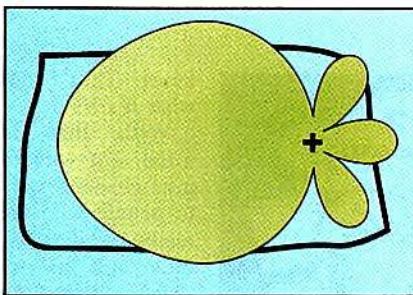


Figure 7. When the base station antenna is placed very far off-center of the desired coverage area, a high-gain directional antenna, such as a yagi, is often needed to cover the area. The yagi would produce a radiation pattern similar to this.

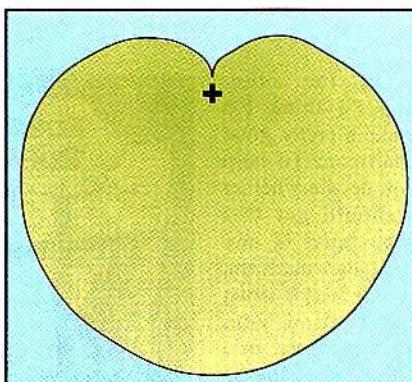


Figure 8. The corner reflector antenna produces this cardioid radiation pattern. It also could be used in a situation where the antenna tower is located near the perimeter of the coverage area.

Figure 7 above shows a service area in which a high-gain directional antenna, such as a yagi, comes into play. The size of the yagi used depends on the gain required to cover the opposite end of the service area. Another antenna that can be used in this situation is the corner reflector. The corner reflector produces a *cardioid*, or heart-shaped, pattern as shown in Figure 8 above center.

### Minimizing interference

Figure 9 at the right shows a situation that requires a directional antenna that is oriented so that the nulls are positioned to minimize possible interference to other stations operating on the same frequency. Points B, C and D represent receivers and locations operating on the same frequency. The idea is to communicate from point A (center) to point D without interfering with receivers at B and C.

First, overlay several transparencies outlining the antenna radiation pattern on

a map of the service area to determine if the nulls are in the proper place to minimize interference. The proper orientation of the antenna then can be determined by adjusting the overlay until the nulls are properly positioned. Once this is done, record the azimuth of the antenna orientation and install and orient the antenna in the proper azimuth.

### Conclusion

As you can see, there is more to selecting a base station antenna than simply gain and directivity. Care taken in the process of choosing the proper antenna can save you many headaches down the road. 'Til next time—*stay tuned!*

### Bibliography

EIA Standard RS-329-A, *Minimum Standards for Land-Mobile Communication Antennas*.

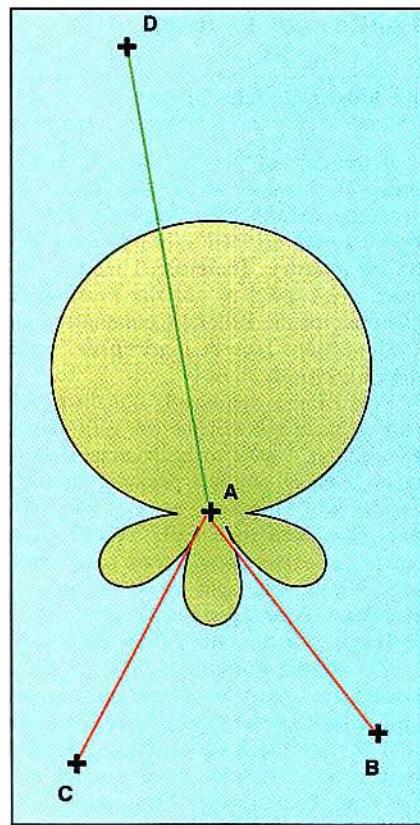


Figure 9. A yagi antenna is used here to null out radiation in the undesired directions indicated by the red lines and to favor the direction indicated by the green line.

Part I—Base or Fixed Station Antennas.

NIJ Standard-0204.01, *Fixed and Base Station Antennas*.

Sinclair Technologies, Technical Notes.



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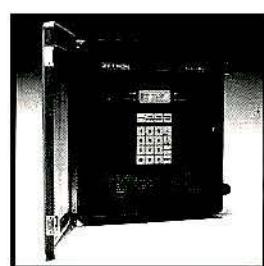
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## Politics not as usual

By Robert H. Schwaninger Jr.

In the spirit of this election year (and to preserve our tradition of "one man, one vote—one *really* bad reason for closing bars") I have decided to bring democracy to our industry. Therefore, I humbly declare my candidacy for the position of chairman of the Federal Communications Commission. [Insert *loud cheers from adoring crowds here.*]

Yes, I know spoilsports out there will rush to point out that the job isn't gained by election. I have to be nominated by a crack team of political personnel managers that will submit my name to the President, who will then reply "Who?" But, since that system doesn't seem to be working too well, I thought we should try this. Besides, I haven't got a snowball's chance in Hades in getting the job the other way.

My resume doesn't qualify me for a nomination by the closed-door-smoky-room crowd. I have never served on the campaign trail for any candidate that won office. I have never contributed more than ten dollars to any political party. I have never taken a job from the federal government. I won't follow any political agenda that requires logic more convoluted than the game "Twister." Also, I have never written a book that seeks to expose the seamy underbelly of politics—I prefer to do that here.

Schwaninger, MRT's regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

On the other hand, I think I'd make a pretty good chairman. To help you decide whether I should get this job, here is my campaign platform. [Band begins drum roll.] Mind you, This platform is a little shaky—maybe only I should stand on it.

### Spectrum

Spectrum is neat stuff—like land. It can be used to create bucolic settings where people are free to roam, like a park. It can be used for teeming highways of commerce, where neat rows of shops are built, one next to the other, each serving the public's need. It can be a chaotic slum, swarming with bad guys and drive-by shootings. It also can be left fallow, producing nothing and sheltering the taxes of the rich—with high fences to keep the public out.

The granting of a license is the offering of a public trust. The government should be saying, in effect, "Here is some of the radio spectrum. We entrust it to you with the understanding that you will actually use it to provide a viable service to the public. If you don't, we want it back. No fair just hanging onto it as a corporate



asset. That's not what it's for."

With that in mind, I'd vote to give channels only to people who are really going to use them, not just leverage them. You will build systems that serve the public—or I'll take your channels back. What else should you do with a company that violates our trust?

### Auctions

I am opposed to rampant use of auctions. Auctions are replacing the

FCC's job of regulating the radio spectrum to assure the delivery of service to the public. The net result is that more companies are turning from service-based profits to Wall Street profits, and over-concentration of spectrum is increasing. For all of the token concessions being offered to small business, the truth is small business simply cannot keep up in a race to throw money at the federal government.

Auction money builds spectrum warehouses, filled with inventory that is kept from the productive ends of the nation's economy. The money raised is a drug for politicians, who use it to go on a temporary high, only to be faced with the long

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hangover of reduced competition, unemployment and instability throughout the industry. Like addicts, the politicians crave more and more, selling everything of value to feed the habit, only to be left with nothing.

Used properly, auctions can be a good medicine for the U.S. economy. But right now, the country (and our industry) is suffering from an overdose—and there doesn't appear to be a rehab clinic in sight.

#### Emerging technology

I thank every inventor, manufacturer and distributor of any new technology that produces a product or service the public wants. We will get to your new ideas as soon as we figure out how to properly regulate the one's we've got. Right now, the FCC doesn't have the political will to enforce its rules regulating crystal sets, much less the newest microwave RF link circuits. So, be patient. As soon as we develop enforcement capacities that work, we'll get to your ideas.

By the way, could you inventor types do the FCC and the American public a favor? Stop coming up with stuff we don't want or need, like HDTV or radio-determination satellite systems or bad

AM stereo designs. As chairman, I won't be giving any spectrum away for these types of boondoggles. Broadcasters: either build HDTV quickly or give back the spectrum. Your collective justifications, ranging from First Amendment rights to making sure the American public still gets free TV, are bull. You know it. We know it—and Congress should have known it when it passed Telecommunications Reform Bill. [Spontaneous air-horn blasts from the balcony.]

#### Small Business

It's time to shift the FCC's focus from giveaways for the richest companies to helping small business. As chairman, I will approve no regulatory plan that shafts the small operator. Small businesses are the biggest employers, pay more taxes and contribute more productivity per person than any segment of large business in the economy. Why is the FCC ignoring this vital source in favor of the downsizing, over-concentrating, spectrum-warehousing, financial-wheeling big boys? Beats me. In my administration, I'm going to revitalize the entrepreneurial spirit in this industry. Okay, that will put some people out of work, but the economy can get along

fine without a few lobbyists, blue-sky artists and big-picture guys. Maybe they could get jobs working as techs? After all, this industry is increasingly short of people who really work for a living.

#### Vote early and often

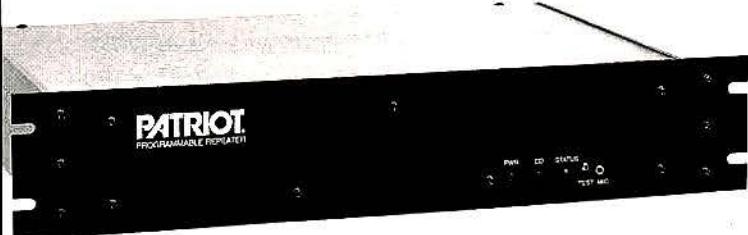
Well, that's my platform. I might add that the FCC would be run in accord with its rules, rather than unwritten policies. I'd also call for commission meetings where the public gets to participate, not just watch. The commission also wouldn't act so doggone offended every time somebody disagrees with it or points out a mistake. A little humility would be a great thing at the commission.

If you want to vote for me, great! Just tear out this column and send it to President Clinton with a note that says, "I'm tired of business as usual—give us Robert!" [Release the balloons.]

If you want to make a campaign contribution, send it to an association that represents your interests, and that would be...oh, never mind. Just keep the dough. The way the commission's been going lately, you're going to need it.



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# Tower down conductors offer little lightning protection

*Lightning-simulator test results indicate that a down conductor connected to a towertop lightning rod adds no significant improvement to the protection offered by a lightning rod bonded to the tower itself.*

By Roger Block

Numerous grounding standards require that a copper down conductor be run along the tower length to a ground rod or to the grounding system. Perhaps those who wrote the standards thought that copper was a better conductor than the tower, or that because the tower is made of steel (ferrous material), its additional induc-

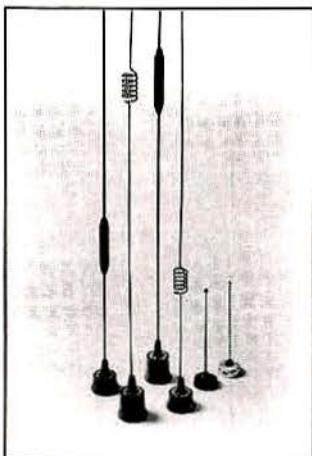
tance would impede the lightning strike energy from flowing to ground. Regardless of the reason, such standards still exist.

These standards address two types of installations, one with the top lightning rod grounded to the tower, and one with the rod insulated from the tower. With the insulated rod, it is impossible to prevent electrical energy from arcing across from the rod to the tower. The instantaneous

voltage drop caused by the down conductor's inductance is measured in hundreds of kilovolts, more than enough to allow an arc from the rod to the tower. With the rod grounded to the tower, not much energy flows on the down conductor

Block is chief technical officer and founder of PolyPhaser, Minden, NV. This article first was published in the June 1995 *Striking News*, a PolyPhaser publication.

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compared to the tower itself.

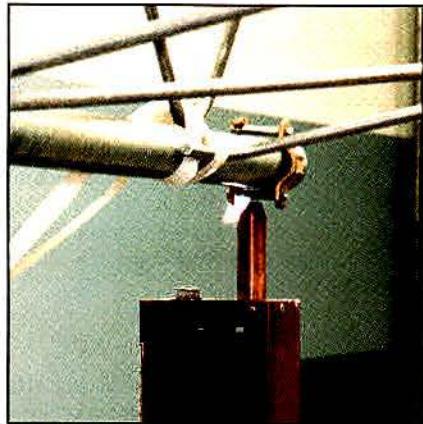
To test this theory, we placed a 10-foot section of Rohn No. 25 tower over our Big Bertha lightning simulator. A 10-foot section of insulated No. 2/0 cable was bonded to the surge input side of the tower. The other ends of the tower and cable were monitored to measure the current carried by each. The setup was "shot" with 5,000V. The results showed that the tower

section carried four times the current carried by the cable. Only 19.7% of the current traveled the cable, and 80.3% of the current traveled the tower.

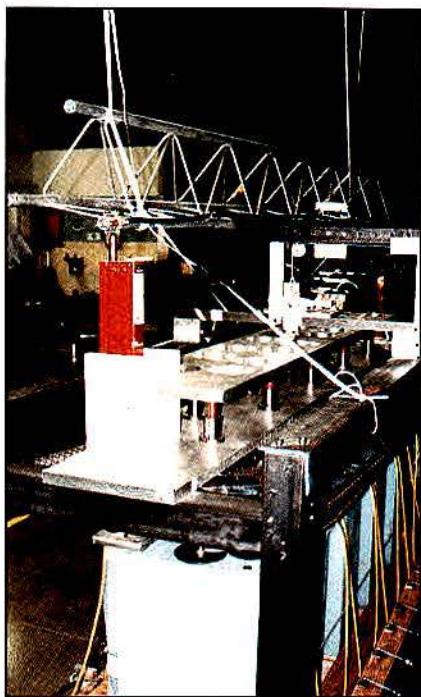
When bare copper wire is used for the down conductor, rain, which is slightly acidic (pH 5.5-6.0) will remove some copper ions on contact. When these ions drip onto the tower, the galvanized coating (zinc) washes away, resulting in rust and decreasing the life of the tower.

In a subsequent test, a 10-foot section of Times Microwave LMR-1200 coaxial cable was bonded to the same tower section over the lightning simulator. This coax has a larger diameter than No. 2/0 cable. The test result showed an advantage in using a coaxial cable instead of a grounding conductor. The coax carried 30.9% of the current, and the tower carried 69.1% of the current. This result shows how coaxial cable can perform a double duty—as a useful transmission line and as a conductor for lightning surge current.

Remember, though, that the tower-mounted lightning rod is only one part of a comprehensive protection system that should include surge suppression devices and proper grounding techniques.



Down conductor shown arcing back to the tower.

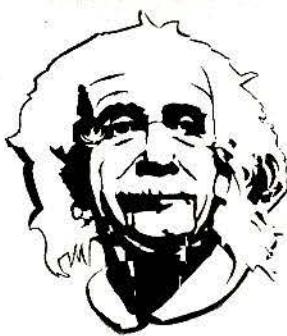


Tower with coax cable tested on Big Bertha.



# TWO SMART IDEAS

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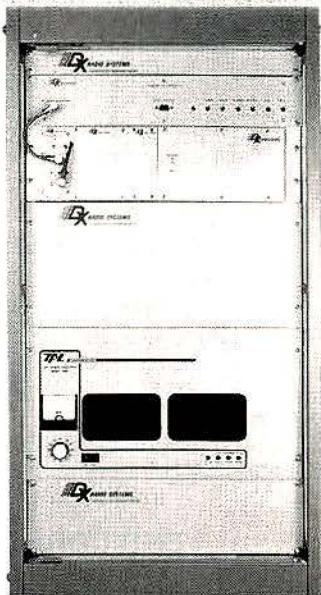


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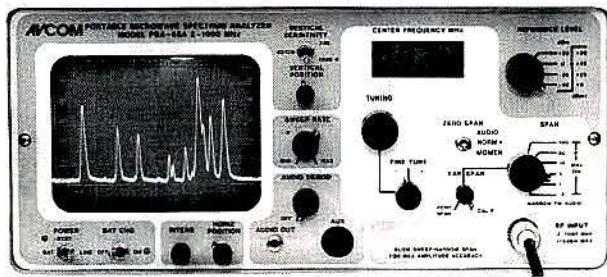
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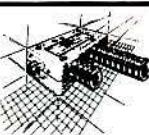
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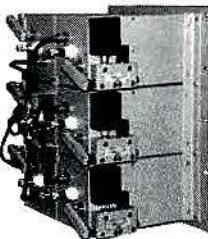
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**N**ews

### Radio communications, paging system operators organize Small Business in Telecommunications

Meeting in St. Louis March 1-2, owners of radio communications and paging systems launched a non-profit trade association to represent those telecommunications businesses with revenues not exceeding \$20 million annually.

The Washington, DC-based law firm of Brown and Schwaninger was named general counsel for the new association, called Small Business in Telecommunications (SBT). "Some people think telecommunications businesses are best categorized according to the technology they use or which spectrum they use," said Robert H. Schwaninger Jr., a partner in the law firm. "Instead, the most important regulatory and economic issues divide telecommunications businesses according to their size."

SBT has formed an 11-member board of directors, and the election of a chairman was expected to be completed by March 15. Annual dues were set at \$250. Additional organizational efforts will take place during the International Wireless Communications Expo, April 24-26, in Las Vegas, NV.

Initially, SBT is sharing office space with its general counsel. Its address is 1835 K St. NW, Suite 650, Washington, DC 20006; tel. 202-223-8728; fax 202-659-0071.

### APCO begins electronic exchange with the FCC

The Association of Public-Safety Communications Officials—International (APCO) is the first frequency coordinator to be certified for the paperless exchange of licensing applications. The FCC's licensing division in Gettysburg, PA, informed APCO to begin sending all license applications electronically through a process known as Electronic Data Interchange (EDI).

The two parties have spent two years developing and testing the system. The computer program for EDI was developed by the association's information systems staff.

APCO International is the designated frequency coordinator for all public safety agencies above 800MHz and for law enforcement agencies and local governments below 800MHz. Applicants requesting licenses using the new FCC Form 600 can now expect speedier service of their applications.

### Selectone reorganizes business units

Selectone, Hayward, CA, has reorganized into two business units. Since its introduction in early 1992, Selectone's SmarTrunk radio trunking system has been the major contributor to the company's growth. In recognition of the product line's importance, Selectone Corporation has changed its name to SmarTrunk Systems. At the same time, a subsidiary was created under the name of Selectone Inc. to take over the engineering, manufacturing and marketing of the "Selectone" product lines, including CTCSS, two-tone sequential burst tone and DTMF tone signaling devices; automatic number identification (ANI) systems; and voice encryption equipment.

Selectone will be located at 3501 Breakwater Drive, Hayward, CA 94545. Phone: 510-781-0376, 800-227-0376; Fax: 510-781-5454. SmarTrunk Systems will remain at 23278 Bernhardt Street, Hayward, CA 94545. Phone: 510-887-1950; Fax: 510-887-4011.

### Pro-Fit moves to new office

Pro-Fit International, Bloomington, MN, is moving to a newly constructed office/warehouse in Eagan, MN. The new building will help accommodate the company's expanding line of custom mounts. The new address is 1335 Eagandale Court, Eagan, MN 55121. Phone: 612-688-3588; Fax: 612-688-9876. Customer service: 800-388-0073.

## **Motorola's new service strategy includes sale of repair centers, construction of central repair/exchange facility**

In a departure from a decades-old business practice of providing customer service through service centers in cities throughout the nation, Motorola is building a central facility for repairs and exchanges. The service strategy, launched by the company's Americas Service Division and Field Service Division, includes the construction of a permanent facility for its Radio Support Center subscriber depot that operates in Rockford, IL. Meanwhile, the company is selling its service facilities.

"Today we find that the most efficient method will be to rely on independent service companies, many of which have been Motorola service shops for many years," said Kevin McHugh, vice president and general manager of the Motorola Field Service Division. "The Rockford facility activities will support those service providers with board-level radio repairs and loaner-exchange programs." Much of the work and contracts previously handled by company-owned service centers was transferred to independent centers by the end of December.

Signal Communications Service, Pom-

pano Beach, FL, is among the companies that have acquired former Motorola facilities. The company bought three facilities in south Florida. About 30 former Motorola employees joined Signal's 16-member staff. "We believe this enhanced team approach will enable us to dramatically increase the level of support available to our south Florida customers," said Jonathan Franklin, Signal's chief executive. "Every company today depends on its radio system for everything from productivity to helping it develop and maintain an edge over competition. We will deliver timely, competitively priced and good quality maintenance for these radio systems."

With third-party servicers and subcontractors handling the bulk of customers'

daily requirements, Motorola has bolstered its support. The Field Service Group provides support at selected customer locations, including preventive services. A central dispatch system and software allows authorized service workers to tap Motorola's service knowledge and database. A new contract management and billing system is being designed.

Product development and marketing teams are developing and managing a broad range of value-added services such as Service Value Pak, the first wholesale service product for Motorola Service Stations, and Disaster Recovery Service specifically designed for large accounts. Future services may include additional loaner-exchange and training products.

## **Sinclair opens Dallas office to cover central United States, Mexico**

Sinclair Technologies is opening another office in the Dallas/Fort Worth area. Bill Busby, sales engineer, will be in charge of the new office and will be responsible for Texas, Louisiana, Mississippi, Western Tennessee, Arkansas, Oklahoma, Kansas,

Missouri and Mexico. The address is Towers at William Square, 2nd Floor, Suite 200, 5215 North O'Connor Boulevard, Irving, TX 75039. Phone: 214-868-9007, 800-747-9126; Fax: 214-868-9008.



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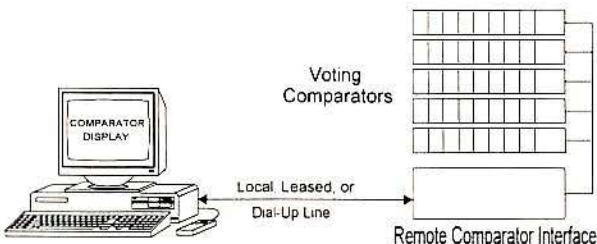
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## New products

### Readers' choice

Of all the new products and services in the August 1995 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

### Portable frequency monitor scans, records on-site

The ScanMan Professional from CompuSpeak is a frequency-monitoring device that scans and records radio transmissions on-site. The self-contained unit is fully self-monitoring and offers a computer interface option. Specific frequencies or blocks of frequencies in various ranges from 72MHz to 928MHz can be programmed for scanning. Accumulated data includes frequencies, signal strength and number of occurrences. The information can be viewed on the ScanMan's LCD screen or downloaded through a Windows-based interface to a PC.



Circle (500) on Fast Fact Card

### Wideband portables offer power, signaling features

The T-90 series UHF synthesized portable radio from Tekk is available in both six- and 12-channel models. The radio features programmable "power-down" to 1W to extend the life of a standard 1,200mAh battery. Other features include 50 CTCSS tones, full DCS, channel scan, priority scan, internal vox, timeout timer and transmit disable. The radio is wideband across the entire 450MHz-470MHz bandwidth. A MIL-STD VHF version is available that delivers 5W of RF power along with the other T-90 features. The radio includes a NiCd battery pack, antenna, belt clip and basic desk-stand charger.



Circle (451) on Fast Fact Card

## Scanner gives mobile units emergency weather info



The Weather Eagle 100 from Thunder Eagle is an NOAA weather radio scanner designed for use by

emergency managers, public safety departments and facilities managers. The receiver's signal processing technology switches to another weather radio channel if the carrier drops or loses audio. The receiver rescans for the strongest signal once per minute, seeking the best of seven possible channels. The unit also time-stamps and stores warnings for later playback or retransmission. Alarm keying is also possible. The system allows mobile users to use DTMF keys to access replays or live weather information. The unit also includes controls to interface with a repeater, including a busy input to silence the weather radio when there is an input on the repeater and tone-detect logic to trip other alarms and macros when there is a severe weather warning.

Circle (452) on Fast Fact Card

## Radio headset features synthesized duplex transceiver

The TD900 Wireless from Eartec is a duplex radio/headset that affords hands-free operation. The system features a synthesized (CPU-controlled), duplex transceiver. The TD900 is available in two types, the Ultra, a lightweight single-ear model, and the Max, a heavy-duty double earmuff headset designed for high ambient-noise environments. The transceiver is DIP switch-programmable and operates on one of forty 900MHz frequencies. Range of operation exceeds one-half mile.

Circle (453) on Fast Fact Card



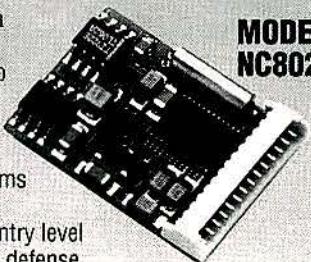
## Power monitor offers eight adjustable alarm outputs

The eight-channel B1658 RF power monitor from Barnett Engineering has eight alarm outputs that can be individually set to monitor for low forward power, high reverse power, or VSWR from any of the eight sensor inputs. Open collector outputs are activated according to alarm conditions specified by the user. The B1658 is fully programmable using a PC-based DOS program. Programmable parameters include the alarm setpoints, selection of RF sensor inputs and radio PTT alarm conditioning.

Circle (454) on Fast Fact Card

# VOICE SECURITY ENCRYPTION

The Model NC802 is a miniature inversion scrambler designed to provide intermediate level security for two-way radio voice communication systems and is a perfect, cost effective solution to entry level voice scrambling as a defense against unauthorized or casual listeners. The NC802 provides eight user selectable carrier codes commonly used by other manufacturers and interfaces easily to most radios with near transparency to the user.



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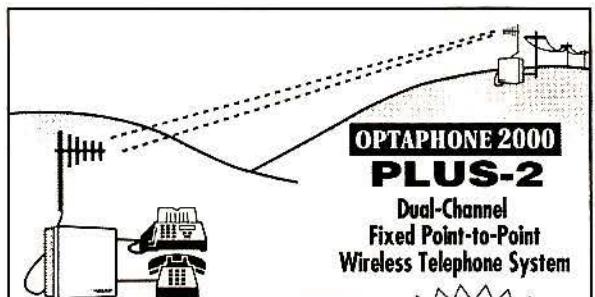
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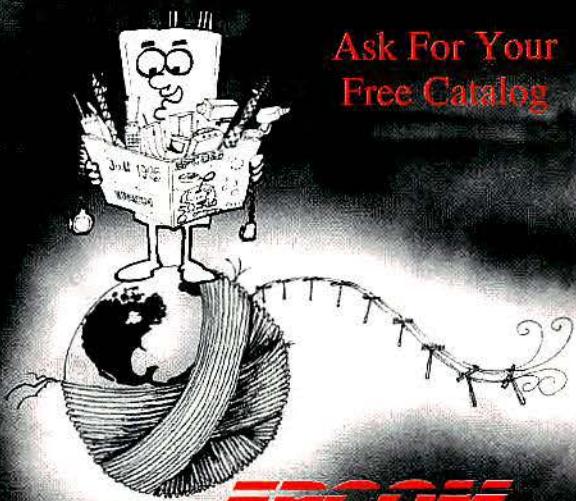
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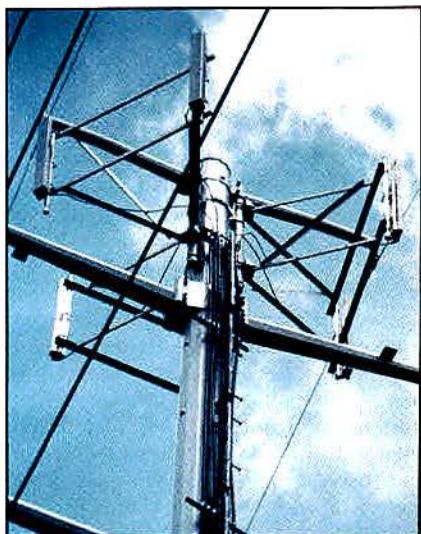
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## New products

Bracket adapts transmission towers for antenna use

Tesco Industries and Baltimore Gas and Electric have jointly developed a mounting bracket for attaching wireless communications antennas to electric power transmission towers and poles. The bracket permits antenna placement and coverage improvement without new tower construction. The Power Tower bracket is designed for mounting to angle leg towers without modifications. An optional adapter kit is available for mounting to electric power poles. Orientation of the bracket is easily adjusted in the field. The bracket is manufactured from heavy-duty structural steel with hot-dip galvanizing for corrosion-free service. Applications include ESMR, PCS, paging and cellular antenna placement.

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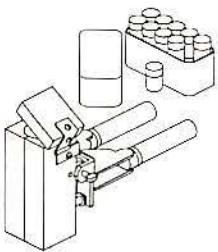
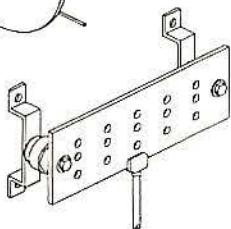
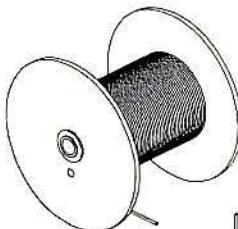
Desktop mic offers unidirectional, low-noise design

Peiker Acustic's PS-30 desktop microphone has a unidirectional electret, low-noise design. The black plastic unit, with hinged-flip access, is available in both two-button and 12-key DTMF versions. The mic is designed to deliver smooth frequency response and electronically balanced output.

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Pager provides tone, vibration for in-house systems

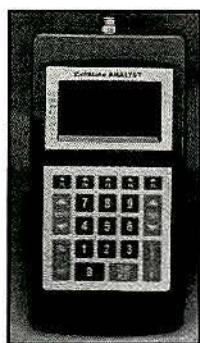


Tekk's TP-450 POCSAG tone and vibrate pager is designed for use with in-house paging systems. Features include low-battery indicator, LED alert, two separate capcodes, belt clip and battery. Units can be ordered with capcodes, or a separate programmer is available, as is private labeling. The unit can be used with any POCSAG in-house system, or it can be used in conjunction with the Tekk PT-400 paging transmitter to provide a complete Windows-based paging system.

Circle (457) on Fast Fact Card

## Hand-held antenna analyst plots VSWR, frequency for 806MHz–960MHz

Advanced Electronic Applications offers the CellMate Antenna Analyst, a hand-held diagnostic unit that covers the 806MHz–960MHz range continuously, graphing antennas' VSWR vs. frequency plots on an LCD screen over a VSWR range of 1:1 to 10:1. The LCD readout plots the SWR curve over the entire frequency range, as well as at single frequencies. The unit also provides measurements of relative field strength and return loss in dB. The analyst has a built-in RF source, eliminating the need for a transmitter. Center frequency, frequency range, step size and other parameters are entered directly with the unit's keypad. Fifteen plots can be named and saved in non-volatile memory for later comparison or downloading to a PC through a serial interface. The unit is battery-operated, or it



can be run with a 12Vdc–16Vdc power source.

Circle (458) on Fast Fact Card

## Lightweight, compact portable features four-channel capacity

The TK-260/360 VHF/UHF portable radio from Kenwood Communications weighs only 14 ounces and includes built-in QT/DQT and two-tone. Features include four-channel capacity, programmable power settings, busy-channel lockout and a time-out timer. Also included are a battery power-saver circuit, a low-battery alert and a heavy-duty antenna mount. The portable measures  $2\frac{5}{16}$ "W  $\times$   $5\frac{5}{16}$ "H  $\times$   $1\frac{7}{12}$ "D.



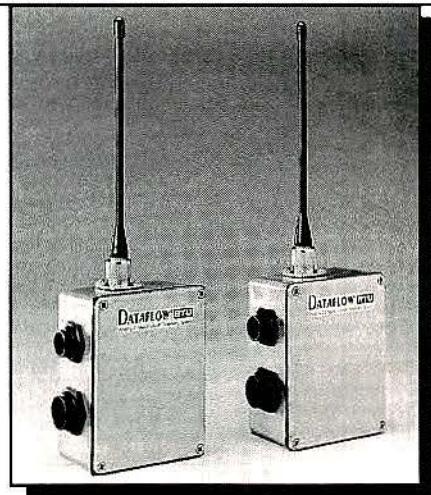
Circle (459) on Fast Fact Card

## E-field meters detect, measure unwanted RF site radiation

The EMR-20 and EMR-30 hand-held E-field radiation meters from Wandel & Goltermann are designed to make precise measurements of electrical radiation from 100kHz to 3GHz. The battery-powered instruments are impervious to dust and are highly water-resistant. They operate for 8 hours on rechargeable NiCd batteries or 15 hours when used with AA alkaline batteries. Measurement is based on triaxial signal-processing circuitry using Digital Axis Processing (DAP). An isotropic omnidirectional probe mounts on the front of the unit. Features include instantaneous or average measurements, self-diagnostics and displays in V/m, A/m, mW/cm<sup>2</sup>, or W/m<sup>2</sup>.



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**DATAFLOW® RTU**  
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Circle (97) on Fast Fact Card

## New products

High-security scrambler provides privacy for radio telephone interconnect

Pacific Circuit Design has developed a full-duplex, high-security scrambler for radio telephone interconnect. The VS-D is designed to interface to the telephone switch or repeater interconnect hardware. The scrambler, activated by the mobile or portable user, provides security for telephone conversations. The VS-D is capable

of multisite application and of serving roaming customers. The unit is available to countries that are not restricted for export from Canada. Pacific Circuit Design is currently seeking distributors, manufacturers reps and OEM business for its line of scrambler products.

Circle (461) on Fast Fact Card

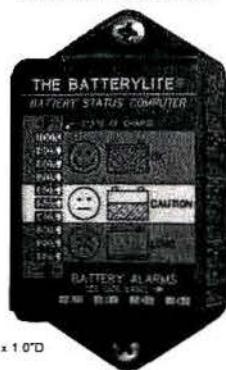
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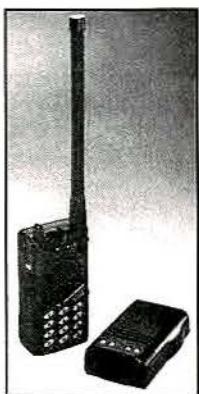
The conference is intended for electric utility professionals who are going through the evolution from a regulated scenario to a competitive deregulated environment. Further, large industrial and commercial customers facing new pricing schemes and government officials and regulators developing and implementing new legislation and regulations and devising new regulatory structures will benefit from this conference.

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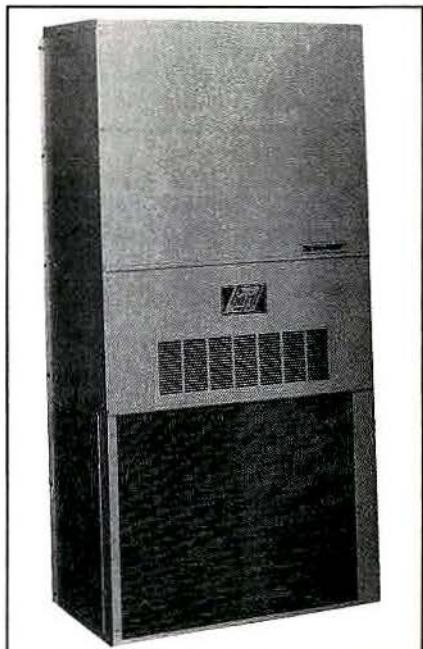
Replacement battery for Visar comes in NiCd and NiMH models

W & W Associates has added a Motorola Visar replacement battery and eliminator to its line of two-way batteries. Both NiMH and NiCd batteries are available. The NiMH model WC-061D-8394 is rated for 7.5V at 2,000mAh. The NiCd model WC-061E-7395 is rated for 7.5V at 1,200mAh.

Circle (462) on Fast Fact Card.



Wall-mount unit provides cooling for larger communications shelters



Bard Manufacturing's WA series vertical wall-mount 6-ton air conditioner has a cooling capacity of 69,500BTU/hr and is available in voltages of 230V/208V, 3-phase and 460V, 3-phase. The unit provides additional cooling capacity for larger communication equipment shelters. Features include high/low pressure switched, adjustable compressor time delay relay, alarm relay contacts and low ambient control. Other features are built-in circuit breakers/pull disconnects, rain hood and full-length mounting flanges.

Circle (463) on Fast Fact Card

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Trunking mobiles offer dual-protocol, 800MHz service with interconnect

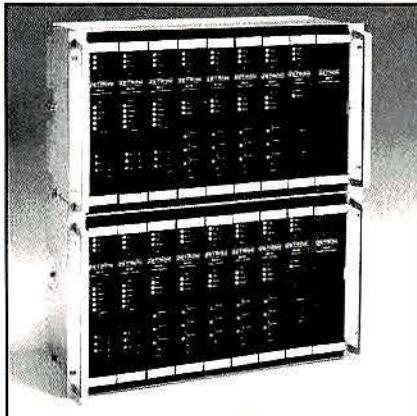


The GX5800T and GX5810T+ data-ready trunking mobiles from **Standard Communications** offer dual protocol, 800MHz operation with talkaround and simple telephone interconnect. The 15W radios are compatible with both LTR and Privacy Plus trunking formats and can be programmed to operate on both formats simultaneously. The GX5800T (left) can operate on as many as 20 systems, 10 groups per system. In the 800MHz conventional mode, the radio programs to operate as many as 110 channels. An optional DTMF mic allows telephone interconnect.

Circle (464) on Fast Fact Card

dot matrix alphanumeric display of system/group identifiers, status icons and operating modes. The radio features assignable soft-keys and a direct connection for scrambler options. The GX5810T+ (right) tracks as many as 10 systems while scanning. In conventional mode, the radio is NPSPAC compliant, and its data I/O supports 9.600bps. The unit scans as many as 10 channels. Both mobiles offer CTCSS/DCS tone signaling. An optional DTMF mic allows telephone interconnect.

#### Control system feature locates mobiles, routes call in multisite coverage



Zetron's Radio Access Control Systems (RACS) now include an AutoSearch feature that automatically locates and routes calls to mobiles roaming in a multisite coverage area. RACS networks provide simple, PBX-style dispatch, selcall communications and interconnect for wide-area, multisite voice and data radio systems. Other new RACS features include automatic registration of mobiles, emergency/priority calling, and multiple signaling protocols, voting and improved supervisory dispatch stations to enhance personnel safety and channel use efficiency.

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#### COMMUNICATIONS RECORDING SYSTEM

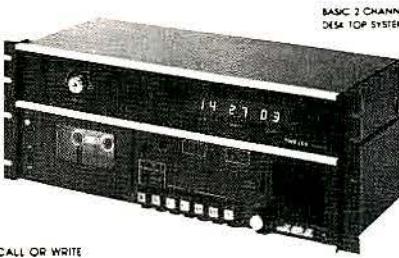
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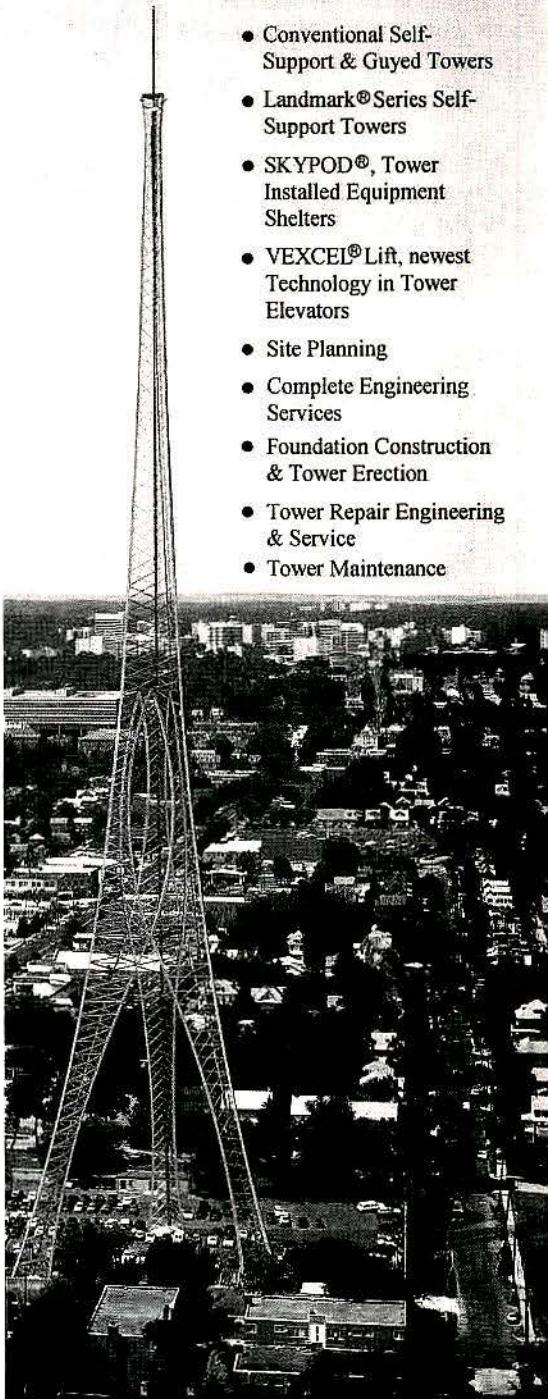
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## New products

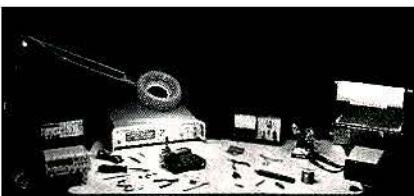
Narrowband receiver fits entirely inside ear canal for covert use



The Microear miniature receiver, available through **Television Equipment Associates**, fits entirely inside the ear canal. The VHF narrowband, professional military-grade FM receiver has automatic frequency control for optimal reception. Designed for security and public safety tactical applications, the receiver operates in the range of 138MHz–190MHz and contains an automatic squelch circuit and a self-adapting filter to reduce background noise. The maximum effective receiving range is one mile. Battery life is 15 to 30 hours. High or low volume settings may be selected by the user.

Circle (466) on Fast Fact Card

Pager kits offer range of complexity for small service, repair businesses



Motorola Americas Parts Division is offering seven pager service kits designed for the small repair business owner or technician. The program is configured for different levels of experience and equipment needs, including: a starter kit, two basic kits, two deluxe kits, a premier kit and a basic solder and repair kit. The kits can be bundled with the Motorola Pager Repair Fundamentals course. The R-1336 starter kit includes an R-1151 Flex-capable code synthesizer, a radiation test fixture and a 1GHz signal generator. Enhancements in the more complicated kits include frequency counters, voltmeters, shielding enclosures, solder and repair equipment for recrystallization, and training enrollments.

Circle (467) on Fast Fact Card

## Multiprotocol wireless modems feature GPS interface, open squelch

The KWM series of wireless modems for UHF and VHF radios from **Kantronics** includes the KWM-1200 (1,200 baud) and the dual-radio-port KWM-9612 (1,200 baud and 9,600 baud). Protocols include packet, Transparent Unproto Packet (TUP), Poll Mode, Line Substitution (LSUB) and Modem Mode. The protocols often can be implemented

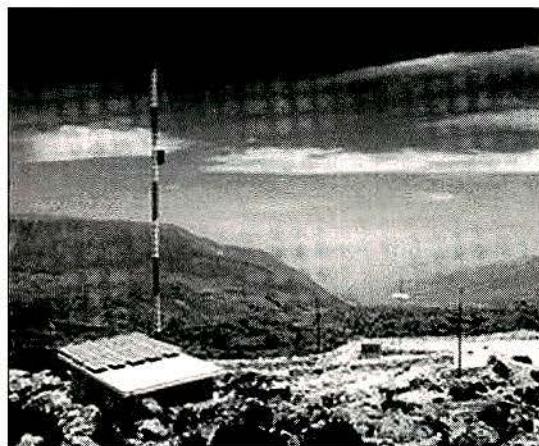
with existing applications that use programmable logic controllers, remote telemetry units or other data acquisition systems. Other standard features include Global Positioning System (NMEA-compatible) interface, open-squelch operation, store-and-forward, remote access, and a built-in calibration mode.

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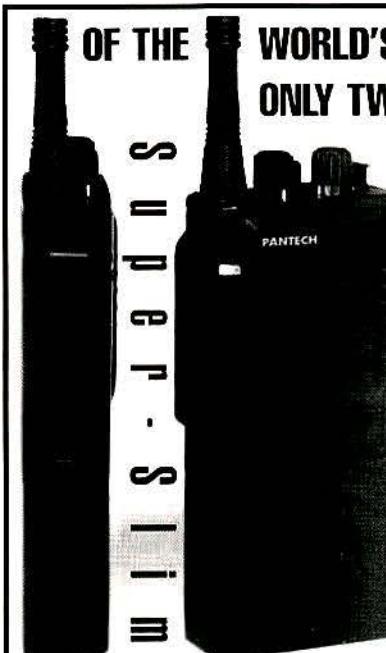
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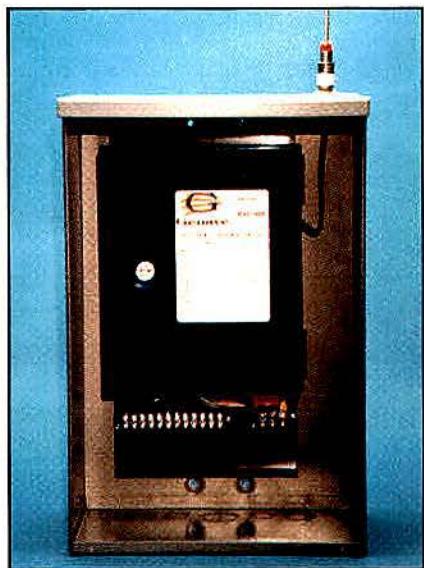
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Circle (104) on Fast Fact Card

## New products

### Controller decodes tones, DTMF for public safety, business applications



Genave's RXC-1005 is a receiver/decoder/controller for public safety, industrial and business applications. It decodes standard paging tones or DTMF signals, then processes the commands to control alarms, doors, sirens, transmitter switches or other equipment. The format-independent decoder detects Motorola, GE, RCA, custom and other types of frequencies and timings. Tone decoding such as two-tone, single-burst, burst, all-call and diagonal tones are supported, as well as DTMF codes to a length of 34 characters. Heavy-duty relays can control various loads from signal source to 220Vac. Field-programmable with a PC, the decoder can be reprogrammed at any time. Information held in EEPROM memory requires no batteries and can be software-locked to prevent unauthorized changes or viewing.

Circle (469) on Fast Fact Card

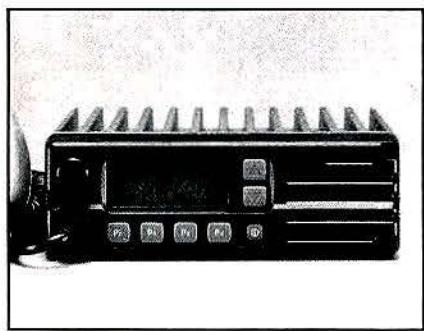
### Disguised mobile antennas offer variety of mounting configurations



The Superband Cellular Look-Alike Antennas from STI-CO Industries are disguised mobile broadband antennas that stretch the UHF bandwidth to 125MHz (400MHz-525MHz). Once installed, the antennas are designed to allow channel changes without retuning. The unity gain antennas are available in several mounting types: magnetic, MAG-SB-450; trunk lip, TRL-SB-450; or an enclosed-coil roof mount, ROF-SB-450.

Circle (471) on Fast Fact Card

### Land mobile receivers feature programming alternatives, external I/O



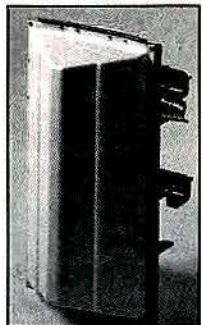
400MHz-430MHz, 450MHz-470MHz or 490MHz-512MHz. The transceivers can be programmed either from the front panel, unit-to-unit using a cloning cable or with programming software. Both 32-channel units have an eight-character, alphanumeric LCD and are expandable to 160 channels. Each channel stores the receive and transmit frequency, alphanumeric notes, transmit power and two-tone decoder code for customized operation. An OPC-617 ACC cable provides for external I/O terminal socket for PA, horn honk, dimmer, 9,600 baud package and PTT. Standard programmable features include a password function, time-out timer, power-save function, busy-channel lockout and dual-priority channel scan. A high-power, front-panel speaker is standard.

Circle (470) on Fast Fact Card

### Electrically controlled downtilt enhances antenna pattern control

CSS Power has added the 820MHz-900MHz SA-10 stripline array to its antenna line. The antenna features a 10dBd gain, 85° horizontal beamwidth at 3dB and 30° vertical beamwidth at 3dB. The stripline feed eliminates an internal cabling network. Built-in electrical downtilt is designed to provide optimum RF pattern control. Maximum VSWR is 1.30:1.

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## Book discusses various approaches to PCN, PCS

*Wireless and Personal Communications Systems* by Vijay K. Garg and Joseph E. Wilkes describes the emerging personal communications network (PCN) and PCS being envisioned. It discusses the recent history of underlying technologies used to synthesize PCN and delineates the alternative approaches being considered. The book from Prentice Hall can be used by the telecommunication managers who are managing PCS networks with little or no technical background in PCS systems and by seniors and graduate students in electrical, telecommunications or computer engineering planning to pursue telecommunications engineering careers.

Circle (426) on Fast Fact Card

## Catalog covers wireless telemetry products

A 30-page wireless telemetry catalog from RF Neulink offers products in the VHF, UHF and 900MHz frequency ranges that are synthesized or crystal-controlled, as well as spread-spectrum transceiver modems.

Circle (427) on Fast Fact Card

## Guide contains site construction, maintenance products

The 1995-1996 *Site Management Buyers' Guide* contains only site construction and maintenance products for SMR through PCS frequencies. The guide from Tessco consolidates the offerings of more than 95 manufacturers of site construction and maintenance products, with side-by-side product descriptions. It includes 328 product pages and three indexes to help locate any item quickly. All new items are highlighted for easy identification.

Circle (428) on Fast Fact Card

## Catalog introduces connector product line

A catalog from Tru-Connector features 7/16 RF coaxial connectors for wireless communications applications. The catalog features a full line of standard connectors in straight, right angle and between-series configurations that fit most popular cables from 0.041" to 0.685" dielectric diameters. Plugs, jacks, panel receptacles and a variety of combination heads and adapters are included. The catalog provides performance specifications and a description of the body, center contact and inner/outer conductor options, as well as line drawings for each item along with compatible cable types.

Circle (429) on Fast Fact Card

## Catalog contains information on hearing protectors

A 16-page color catalog contains many new products, including the H10 series super-attenuating hearing protectors, as well as several new communication products for high-noise areas. Peltor is one of the largest manufacturers of muff-type hearing protectors.

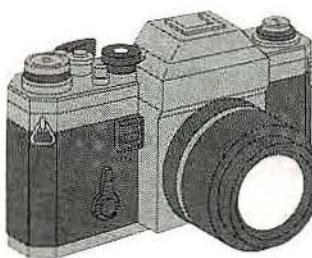
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## Book presents a tutorial development of nonparametric detection theory

*Introduction to Nonparametric Detection with Applications* by Jerry D. Gibson and James L. Melsa presents a tutorial development of nonparametric detection theory written from the engineer's viewpoint, using engineering terminology and stressing engineering applications. The book from IEEE Press is written at a level understandable to seniors and first-year graduate students and requires only a basic understanding of probability and random variables.

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people

**Daniel F. Akerson**, the previous chairman of General Instrument, Chicago, becomes chairman of Nextel Communications, Rutherford, NJ, replacing **Morgan E. O'Brien**, who becomes a vice chairman. Akerson also assumes responsibility as chief executive officer, a title previously vacated by former company president **Brian D. McAuley**, currently a vice chairman. **Dennis Weibling** who had been serving as acting chief executive officer, continues as a member of the company's board of directors and operations committee. **Tim Donahue**, the company's current president, assumes additional responsibility as chief operating officer.

**John Karstrand** departs Communications Associates, Joliet, IL, as sales manager to join JBro Batteries, Lisle, IL, as national manager, land mobile sales.

E.F. Johnson, Burnsville, MD, has increased the staff of its data telemetry business and transformed it into a separate Data Telemetry Division within the company.

**Guy Kelnhofer**, director of international sales for the Russian Federation, advances to general manager of the Telemetry Division.

**Vicki Hartwigsen**, director of sales and marketing for the telemetry group, becomes director of telemetry marketing for the new division.

**Bob Cervenka**, manager of telemetry engineering for the telemetry group, becomes manager of telemetry engineering for the division.

**David Hammick** leaves Dataradio, Atlanta, as sales manager to join E.F. Johnson as director of telemetry sales.

**Mark Kodet** departs Dataradio as manager of applications to become manager of telemetry applications.

**James Cahill** departs Maxon America, Kansas City, MO, as customer service supervisor to join Tekk, Kansas City, MO, as customer service manager.

**Michael A. Fabiaschi**, vice president of sales and support for Racotek, Minneapolis, MN, advances to president, replacing **Richard A. Cortese**, who becomes vice chairman of the board of directors.

**Joe Pleitgen**, a former police officer in Colorado, joins Cerulean Technology (formerly PacketCluster Systems), Marlborough, MA, as regional sales manager for PacketCluster mobile data communications systems.

Changes at McCaw International, Kirkland, WA:

**Keith Grinstein** leaves AT&T Wireless Services, Seattle, as president of the aviation communications division to join McCaw International, a subsidiary of Nextel Communications, Rutherford, NJ, as president.

**Mark B. Nelson**, senior vice president of engineering, operations and technology development for Nextel, advances to senior vice president and chief engineer.

**Tsippora Dingott** exits Bellcore, Livingston, NJ, as executive director of marketing for its Personal and Wireless Communications Business to join Comsearch, Reston, VA, as director of the Wireless Software Division.

**Martha Hill** leaves OCS Technologies, Pleasanton, CA, as vice president of marketing to join PSI International, Fairfax, VA, as director of sales and marketing for the public safety and criminal justice business unit.

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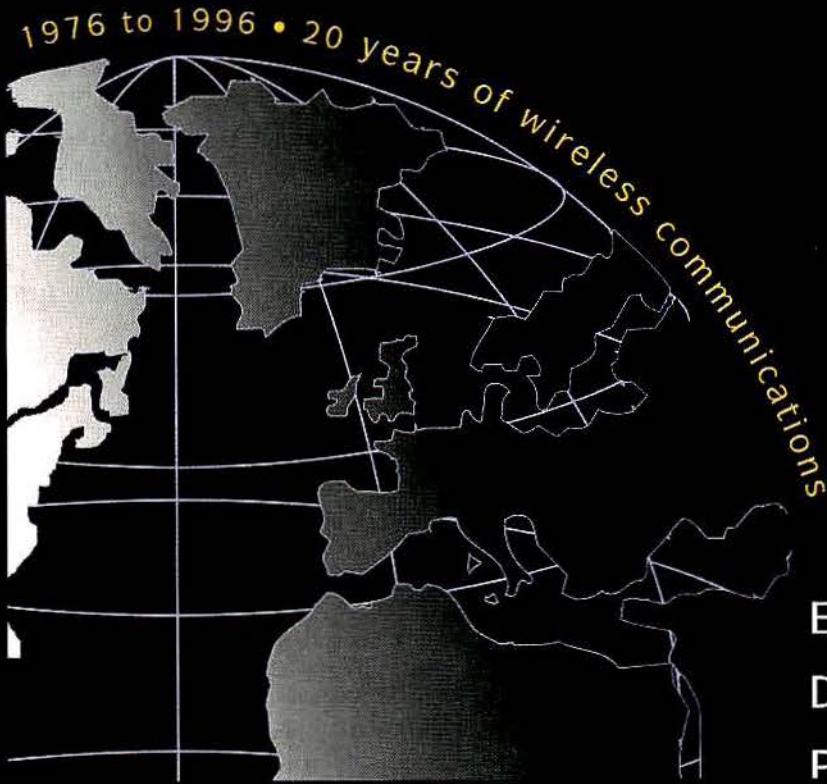
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### **Closing Session:** Friday, April 26, 1996

#### *Establishing Identity Amid Convergence*

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### Thursday, April 25, 1996

- 9:00am - 6:00pm Exhibits Open  
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### Friday, April 26, 1996

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Wednesday, April 24, 1996 - 8am - 5pm  
**SC3** Part III: Amplifier Design  
Thursday, April 25, 1996 - 8am - 5pm

### Special Course, Track Two: Engineering Applications

- SC4** Practical High Frequency Filter Design  
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**SC5** Oscillator Design Principles  
Wednesday, April 24, 1996 - 8am - 5pm

### Special Course, Track Three: Advanced Techniques

- SC6** Digital Modulation and Spread Spectrum for Wireless Communications  
Tuesday, April 23, 1996 - 8am - 5pm  
**SC7** RF Power Transistors and Amplifiers: Principles and Practical Applications  
Wednesday, April 24, 1996 - 8am - 5pm

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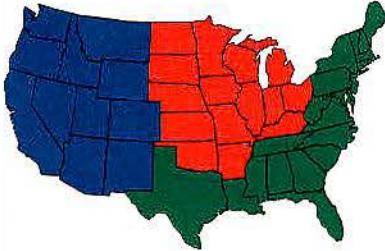
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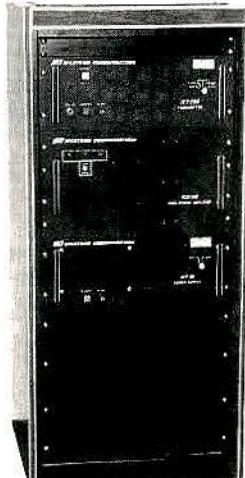
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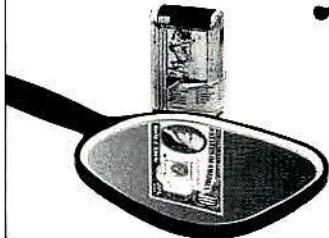
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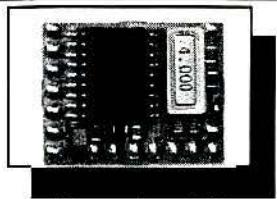
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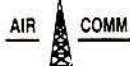
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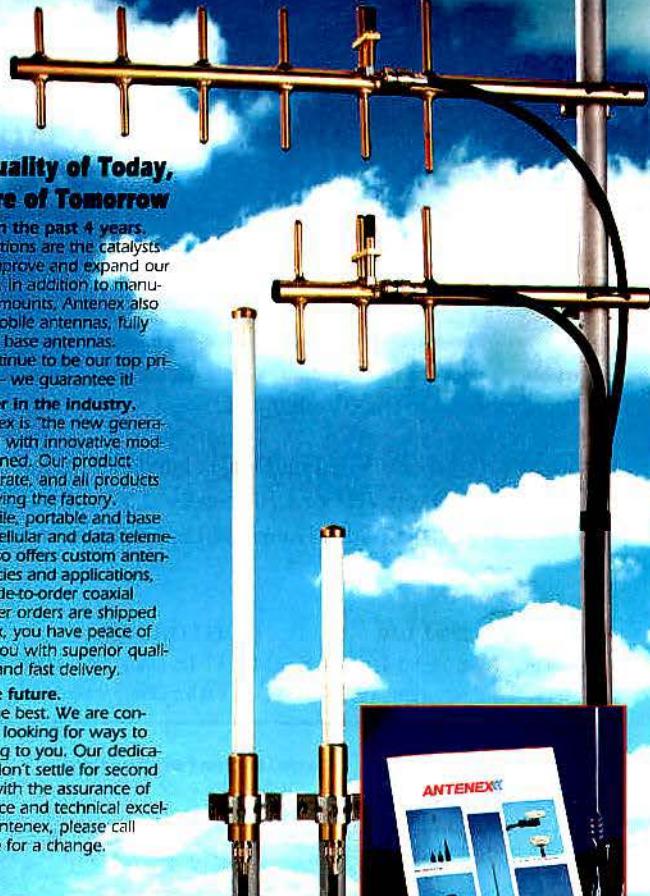
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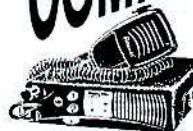
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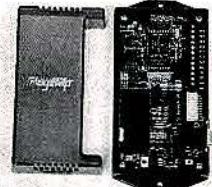


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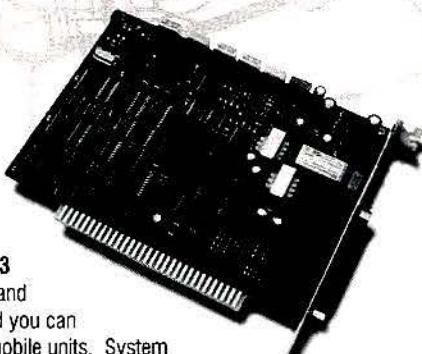
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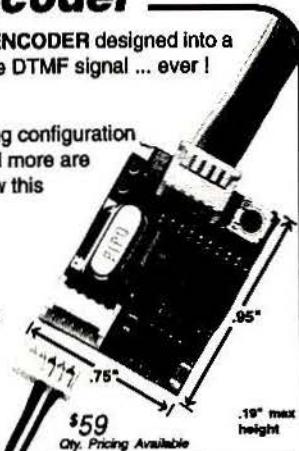
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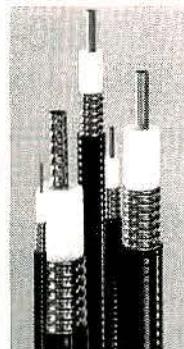
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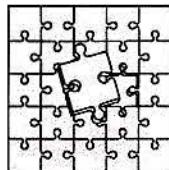
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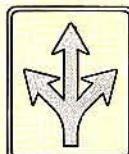
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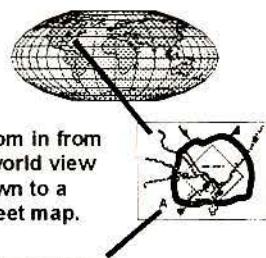
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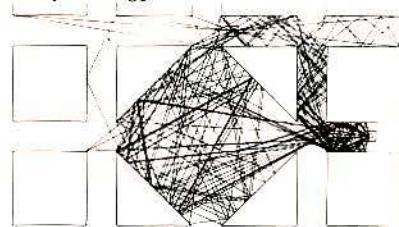
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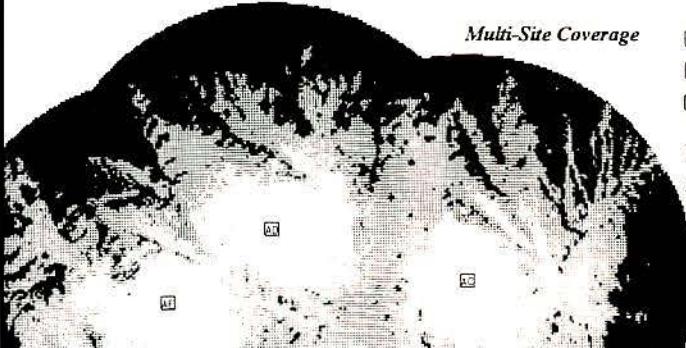


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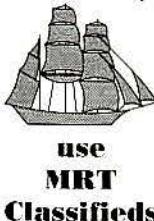
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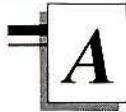
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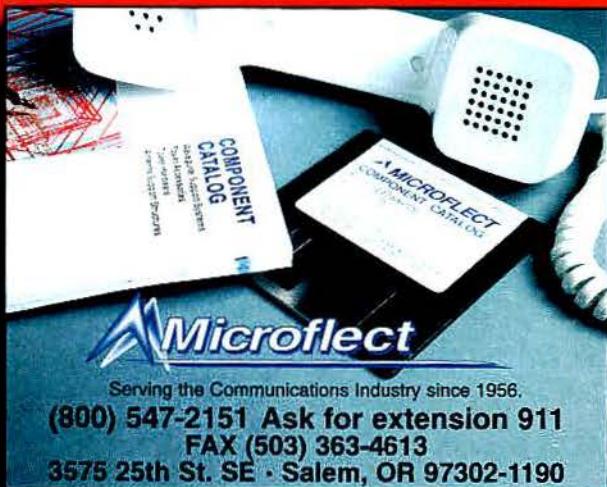
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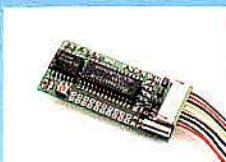
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